THE

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CONTENTS:

	PAGE
Fuel Economy	621
Three-Wire Distribution with a Single Dynamo (*illustrated*)	624
Couplings for High-Tension Mains (*illustrated*)	625
Small or Sub-divided Arc Lights	626
Electric Haulage Plant (*illustrated*)	626
Proposed Cables under the Pacific	627
The Electric Station of the Citizens' Light and Power Company of Rochester, N.Y. (*illustrated*)	627
Cost of Electrical Energy.—II.	630
Electric Traction	631
Correspondence:—A Call for More Imagination as a Factor in the Progress of Physical Science, and a Few Remarks on Maxwell's Electrical Theory	633
The Resistance of Selenium	634
A Loud-Speaking Telephone	635
A Complaint	635
Cost of Electrical Energy	635
Some Attemps to Record Periodic Changes	635
Chelsea Vestry and Dust Destructors	635
Transformers and their Industrial Applications	637
Business Notices, &c.	637
Contracts Open and Closed	638
Notes	639
City Notes, &c.	641
Traffic Receipts	642
Share List of Electrical Companies	643
Proceedings of Societies:—	
The Institution of Electrical Engineers	644
Physical Society	646
Bedford Electric Lighting	647
New Patents	648
Abstracts of Published Specifications	648

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FUEL ECONOMY.

IF we could choose things in this world just as we would wish, it is probable that smokeless Welsh coal of best quality, but less friable than the actual article, would be found everywhere in place of the more bituminous coals so common, and which present greater difficulties in their utilisation. It is, however, the business of engineers to utilise such natural products as are either found locally or can be most cheaply brought to hand, and it does not occur to us as being particularly good engineering to reject products whose utilisation may be more difficult than other and dearer substances. In this light we look upon the question of bituminous coal and its consumption in electric stations. The whole question is one of smoke, and the subject has come to the front of late by reason of Mr. Crompton's paper on the cost of electrical energy, wherein it appeared that the author, who has a particular leaning to a certain class of boiler, condemned, not merely other boilers, but all the bituminous coals, because they could not be smokelessly burned in his pet boiler. Now, is it not better engineering to make furnaces that will use the cheapest attainable fuels in a satisfactory manner? It has been pointed out in these columns that practical experience has fairly well demonstrated that to burn bituminous coal there must be thorough mixture of the hydrocarbon gases with fresh air admitted above the fire, and the mixed gases must be heated to a certain temperature in order to ignite, and there must be space for combustion to complete itself. It is because of this last requirement that some engineers condemn the fixing of Galloway tubes in Lancashire or Cornish boilers, for the tubes offer an obstruction to the continuous combustion of the hydrogens. The item of sufficient temperature is secured by the passage over the fire on the grate of the gases, and the fresh air, which are thus heated to the required point. It is this that renders the ordinary make of water-tube boilers so smoky, for in it the gases rise straight up from the fire, and pass at once between the water tubes, where they are cooled forthwith below ignition point. The admixture of air takes place usually through openings in the furnace door, and these require regulating to suit the amount of green fuel on the fire. It is evident that in the Lancashire boiler all the above requirements are present, but, like all other boilers, it has the fault of surrounding the fire with water cooled plates, whereas a furnace ought strictly to be of refractory materials. Now, when hand fired at intervals, there are periods of heavy gas production and of small gas production. A skilful fireman will fire down one side only of a furnace, and he will fire upon one side of one furnace of the next boiler, and so on, placing fresh fuel on every furnace in rotation, but not completely firing the two furnaces of one boiler right on end. Still, each stoking implies a door opening and a cooling down effect, which is a source of loss. Again, openings may be made for air to enter a furnace, but if the draught speed

is less than 15 feet per second, there is danger of smoke. Of course, an ordinary fair draught will give an entrance speed of about 30 feet per second. Therefore, if the draught be insufficient, a steam jet supplying *dry* steam above the fire door, and directed about on the middle of the fire length, will induce an air admission and burn the gases. It is because of this need of air above the fire that the system of forced ashpit draught is a failure in regard to smoke. The furnace is too full of pressure to allow any more air to enter at the door. The ashpit draught is only fit for coke or anthracite. When we examine hand firing, and note these various points, we see at once that for a somewhat critical operation in practical chemistry the process is not continuous, and furnaces are alternately overworked and underworked in respect of their gas consuming duties. We see also that the more a fireman endeavours to render the operation continuous the more cold air is badly admitted at widely open doors in most excessive volume, for air requires admitting in divided streams by perforated plates, and all admission by the open door is so much waste, for the air cools everything in its path and prevents the ignition of the gases for the time being. At critical periods it is not uncommon to see a factory engineer stand by the firemen and open and shut the door for each shovelful of coal thrown on, simply to avoid this loss and keep his engine up to speed. Obviously these considerations lead up to the point of stoking being continuous, and air admission also being continuous, and this is the *raison d'être* of the mechanical stoker, to a very great extent. No system of stoking has proved better in principle than the century-old method of coking each fresh charge of coal upon the front part of the grate, which was, as now, made solid, and called the dead plate. In old times the dead plate was much larger than of late years it has been made, for its true use has been largely dropped for the inferior and smokier spreading system of firing. In mechanical stoking the spreading system has been used, but it is apt to fill the flues with dust and cover the neighbourhood around with dust also, and mechanical stoking seems to have resolved itself into the coking system, wherein coal is pushed forward into the furnace, ignites on the dead plate, gives off its hydrogens there to travel over the fire on the grate, and finally itself be moved forward by a moving grate until it tumbles over the end of the bar to fall into the ashpit in a heap, which gradually burns quite dead, and is removed from time to time as ash and loose clinker as it accumulates, care being taken to leave sufficient to obstruct the free opening against the admission of air *viâ* the ashpit. An inspection of a mechanical stoker at work—Vicars's, for example—will reveal a continuous feed of fuel and a continuous supply of air. The air supply is not so obvious, but it is to be noted that for a continuous feed of coal the openings for air do not require to be more than, perhaps, one-fifth or one-eighth what is needed when the firing and air admission are intermittent, and quite a quantity of air passes in *viâ* the coal hoppers through the coal itself. Now, quite apart from the question of the evaporative power of fuel is that of actual cost per 1,000 gallons evaporated. In Mr. Crompton's paper, we find no mention of this. We may, for argument's sake, allow all that Mr. Crompton says about the superiority of Welsh smokeless coal in evaporative duty, but still we must point out that, given smokelessness, the real question is the cost of evaporation, not the mere excellence of the fuel. In Mr. Ellington's paper* there is given an account of a Lancashire boiler trial with rough slack bituminous fuel, the particulars of which test we need not give further than to say that the coal evaporated 10·59 lbs. water from and at 212°, at a cost of 4s. 5·45d. per 1,000 gallons. The coal was burned at a rate of over 20 lbs. per hour per square foot of grate. Again, in *Engineering* of October 2nd, 1891, Messrs. Donkin & Kennedy's tests of this same boiler are given as made at the same time, but with Welsh fuel, costing 20s. as against 9s. of the slack coal of the previously given test.

The total water evaporated was but little more, but the rate was 12·4 lbs. per lb. of coal from and at 212°, and the cost was 8s. 5·12d. per 1,000 gallons one day, and 8s. 4·22d. on another day, the fuel being burned at the rate of about 16 to 17 lbs. per foot of grate. The Vicars mechanical stoker was used in both instances, and as there was no smoke in either case, it is clear that the bituminous coal was the better fuel for the man who had to pay the bills.

Similarly, in a trial of a Fairbairn boiler at the Wapping pumping station of the Hydraulic Power Company, Mr. Ellington† found that bituminous coal at 9s. per ton gave a cost per 1,000 gallons of evaporation of 5s. 3·41d., as against 10s. 9·80d. for Nixon's navigation at 26s.

The air-compressing engines used in the construction of the Glasgow Underground Railway took steam from boilers fitted with Vicars's stoker. The boilers were in St. Enoch Square, and no smoke was made. The Liverpool Overhead Electric Railway uses the Vicars stokers, and the City of Manchester uses them also at the municipal electric light works, and finds no smoke is made. We ourselves hear from an entirely different source of the success of another mechanical stoker of the coking type, viz., Hodgkinson's, and have seen magnificent fires with the Jukes furnace in under-firing boilers on the coking system, and, generally, there is sufficient information to warrant us in saying that means are at hand for using bituminous fuel without producing smoke. No doubt among the makers of mechanical stokers who are called on to show a saving in the coal bills, as compared with costly Welsh coal, there is not that inducement to secure even the full economy of bituminous fuel, for the difference in price already secures an enormous saving in cost of steam. But as mechanical stoking becomes more common, the prices of the competing fuels are sure to be better equalised than they are at present, and it will be desirable to secure the full effect of the slack coal.

Nothing under 12 lbs. evaporation from and at 212° should content engineers. Above all, fires require to be kept thick; thick fires are less likely to admit useless masses of air to cool down the flues. In a thin fire, whether stoked by hand or machine, much useless air is admitted, both by reason of the fire having too open a nature to sufficiently break up the entering air, and by reason of the liability to burn into holes, leaving the grate bare for the inrush of large volumes of air, which are worse than useless. If we consider that for each lb. of coal burned at least 12 lbs. of air are absolutely necessary, and usually as many as 24 lbs. are used, it is easy to see that when the chimney gases are in each case reduced to one-fourth the temperature of the furnace, the furnace using the least air must be securing an economy over

* *Minutes of Proceedings*, Inst.C.E., Vol. xciv., Part 4.
† *Minutes of Proceedings*, Inst.C.E., Vol. cxv., Part 1.

its rival of about 12 per cent. In an ordinary carelessly-worked fire, 5 per cent. is quickly secured by a little attention. In mechanical stoking the grate must be effectually covered by the fire, and there must be no chance for air to get through wastefully. After the proper working of a machine has been secured, it is not difficult to maintain, and it is needless to say that if anyone wishes to employ mechanical stokers in order to save in the quality of their attendants, they will be disappointed. The *quantity* of attention may be reduced, but the *quality* ought to be maintained, as it should be with all kinds of machinery. Hoppers have to be filled with coal at a considerable height above floor. It is unfair to ask this labour from a fireman. Mechanical elevators are easy to apply, and the want of them has damned many a mechanical stoker that would otherwise have been found a success. The writer has seen some hundreds, and heard the freely expressed opinions of firemen, and is convinced of this.

We would add that, useful as an economiser may be to absorb residual heat at its surfaces of lower temperature, the idea that it is of any use to cover the mistakes of a fireman by acting as a heat trap, as suggested by Mr. Crompton, is altogether erroneous. If a fireman makes a mistake it cannot be undone. No action of the fireman can leave a lot of heat to be trapped later on. The result of all the fireman's mistakes is reduction of furnace temperature. If any gases leave the furnace unconsumed, there is no fresh ignition possible at any point beyond. The mistakes of a fireman are preventible or coverable at the furnace door alone, and to this end mechanical stoking addresses itself; but mistakes which cause a reduced temperature in the furnace act prejudicially upon the economiser also. There is nothing of a heat trap in it beyond what is designedly arranged. Indeed, with the worst attention at the boiler, one can imagine that the economiser would be rendered nearly incapable of performing its office—just the very opposite conclusion from what we were invited to accept.

Hollow *v.* Solid Cores.

THE vexed question of tubular cores is a matter which has engaged the attention of many electricians, prominent amongst them being Von Feilitzsch, Sturgeon, Pfaff, Joule, Nicklés, and Du Moncel. The subject has chiefly been approached from an experimental point of view, and the best known results are those of Von Feilitzsch. In his experiments a set of thin iron tubes, which could slide inside one another, was prepared: they were all of the same length, 11 cm., but their peripheries varied from 6·12 cm. to 9·7 cm. These tubes could be pushed within a magnetising spiral, to which either small or large currents could be applied; and their effect in deflecting a magnetic needle was noted, and balanced by means of a compensating steel magnet, from the position of which the forces were reckoned and the magnetic moments calculated out. The conclusion arrived at by Von Feilitzsch was that the magnetic moment of short hollow cores is hardly inferior to that of solid ones, *ceteris paribus*, and saturation not being approached. This conclusion has received an elegant, though qualitative, interpretation from Prof. Silvanus Thompson, who says that with small magnetising forces, and when even the least quantity of iron is present and at the same time far from saturation, the main resistance to magnetisation is that of the air paths, and is the same whether the total section of iron in use is large or small. There is no need whatever, therefore, for the assumption commonly made that the central fibres of iron cores are less easily "reached" by temporary steady magnetisation than those near the skin; such a state of things would only be proved if the same result were obtained with hollow endless rings, which is certainly not likely. The classic experiments of Von Feilitzsch have been repeated lately and extended by Prof. Grotian (*vide Wiedemann's Annalen*, l., p. 705) and by Professor H. Du Bois, the latter of whom contributes a paper entitled "The Magnetisation of Hollow and Solid Cylindrical Cores," to the *Annalen*, li., p. 529.) A short account of this paper is given in the current issue of the *Phil. Mag.* The particular case of a cylinder being one of those in which the modern "magnetic circuit" notion does not lead up to quantitative results so well as the more orthodox theory of induction: the latter had to be applied and immediately yielded the following general rule:—If for cylindric or prismatic bodies of given length, and any shape of section, the "demagnetising factor" be proportional to the latter and not too small, then the magnetic moment will be practically independent of the section for fields which are not so strong as to produce an approach towards saturation. Both premises of this rule are shown by Prof. Du Bois to apply to thin hollow cores, for which it is thereby easy to draw the curves of magnetic moment (originally used by Von Feilitzsch in his investigation), and impressed field up to thorough saturation for any given dimensions. An illustrative diagram of these curves is given, which presents exactly the same aspect as the experimental diagram in Prof. Grotian's paper.

Fishing up to Date.

HE who would venture on a new *Compleat Angler* must needs be daring in the face of Izaak Walton's immortal "Discourse of Fish and Fishing." Yet this is practically what Mons. G. Trouvé appears to have done. And as if fearing lest his *Nouveau Système de Pêche* should be a mark for the scoffers and the proud of heart, he has gummed upon the title page an awe-inspiring list of his several scientific attainments, and tabulated the names and nature of his various inventions: behind these, we presume, he takes shelter and feels safe. Mons. Trouvé has devised a system of nets combined with electric lamps, which, he claims, will supersede the gentle art which is the "contemplative man's recreation." What Piscator, who was wont to discourse so poetically to his friends, Venator and Auceps, on the art of taking fish, would say, could he have a chat with Mons. Trouvé, we are at a loss to imagine. It is well that those worthies are no more. Electric netting in its more important applications relates to sea and lake fishing. The nets are illuminated by means of strong incandescent lamps as they lie extended in the water. Some of these lamps are capable of being floated on the surface, others are suspended at certain depths. Fishes being naturally of an enquiring mind, foregather in the neighbourhood of the light in shoals, and just at the proper psychological moment, when the interest and the crowd are at the highest, the net closes and the unhappy fish may then begin to think of Billingsgate. But Mons. Trouvé goes farther than this. Why, he says, adventure the stormy ocean in quest of the succulent conger, the lordly cod, the elegant sole, and the appetising lobster? You only have to make a huge enclosure of nets in a convenient harbour, leaving a narrow opening for the fish to enter, then arrange your electric lamps in a sufficiently attractive manner, and the fish will come crowding in all ready to be cooked and eaten. You may even use such an enclosure, if it is placed on suitable parts of the coasts, as a sort of fish preserve and breeding establishment. In short, nothing is to prevent the turbot, for example, from becoming as much domesticated as the pheasant. Mons. Trouvé has been characteristically thorough. He has devised means for closing the ordinary "electric nets" automatically when a certain weight of fish has been secured, and everything is so arranged as to need the minimum attention. By a mere oversight he has not yet invented any apparatus for selecting from the preserve, say, a fine specimen plaice, eviscerating him, egg-and-bread-crumbing him, and frying him. This is doubtless to come. It is difficult to be quite serious over this matter, and Mons. Trouvé's twenty odd pages provide no encouragement. At the same time, not a single reference is made to any occasion on which these nets have received official trial, and, in spite of the sensational illustrations, we are induced to wonder whether the system is installed anywhere at present save in the brain of the inventor.

THREE-WIRE DISTRIBUTION WITH A SINGLE DYNAMO.

Hopkinson's well known system of distribution, known as the three-wire system, has the drawback of necessitating, at least in principle, the employment of two generators.

The endeavours made up to the present to realise with a single dynamo the advantages of this system have met with no success, on account of the large sparks which flash from the third brush applied to the collector.

The Fives-Lille Company, which has just undertaken an electrical service, has, says *L'Industrie Electrique*, patented an arrangement which enables a system of distribution by three wires to be fed with a single dynamo, and that without the production of sparks at the attachment of the neutral wire.

Fig. 1 represents the armature of a continuous current machine, turning between the poles N and S. To simplify the diagram the collector is not shown; the brushes, B_1 and B_2, are placed directly on the winding, which amounts to the same in principle. The two lamp groups, 1 and 2, are connected by the principal conductors, L_1 and L_2, to the brushes, B_1 and B_2. The armature contains a bobbin, R, of high self-induction and low resistance. The high value of the self-induction may be obtained by the employment of an iron core, forming a closed magnetic circuit. This bobbin is connected to two diametrically opposite points, *a* and *b*, of the armature. Between these two points, during the motion, an alternating tension will be produced, as we know; but owing to the high value of the coefficient of self-induction, the alternating current engendered in the bobbin will be very weak. The point, O, the middle of the bobbin, possesses the mean of the potentials of the other parts of the winding, and not only is the difference of potential, *a*, *o*, equal to *b*, *o*, but at the same time the difference of potential between the points, B_1 and O, is equal to that between B_2 and O.

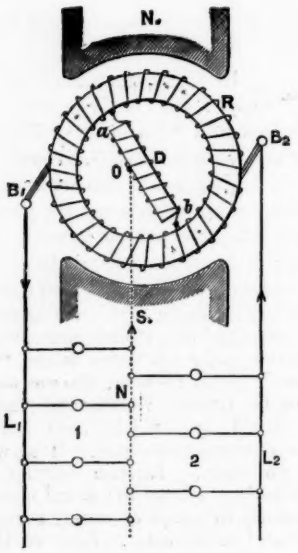


Fig. 1.
Diagram of the Arrangement of the Equalising Bobbin.

We now connect the neutral conductor, N_1, by which groups 1 and 2 are placed in series, to point O, for instance, by means of the axle of the dynamo.

If 1 and 2 contain the same number of lamps their tensions are equal, and the neutral wire remains without current when it is connected to point O. But if more lamps are introduced into group 1, there will be a greater absorption of current, and the excess will return by the neutral wire in the direction indicated by the arrow. On arriving at point O, this current will divide, and as it is continuous, it will pass without difficulty through the self-induction bobbin and come back into the armature.

The result is, that the two groups of lamps are independent. When one consumes more current than the other, the tensions will still remain equal, since the excess of current returns into the armature almost without any loss from resistance by the neutral conductor, N, and the bobbin, R.

Of course it will not always be possible to make the bobbin, D, turn with the armature. In this case it will be fixed outside the machine and the ends connected by means of rings and brushes with the two points, *a* and *b*, of the armature. This arrangement is shown in fig. 2.

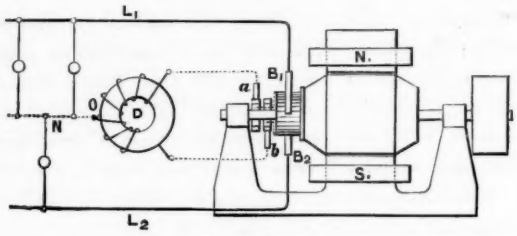


Fig. 2.—Equalising Bobbin Fixed Outside the Machine.

Dynamos supplied with bobbins of this nature can also be employed as tension regulators, especially in a case where the central station, C (fig. 3), is at a distance, and furnishes the current under a tension equal to the total tension of the two groups of lamps. In this case, we have only to introduce near the localities where the current is to be utilised, one or more of these dynamos provided with inductive bobbins receiving the current from the principal conductors into their brushes, and then starting as motors (fig. 3). The neutral wire has not then to be connected to the central station, which is situated at a distance, and thus a considerable saving of wire is effected.

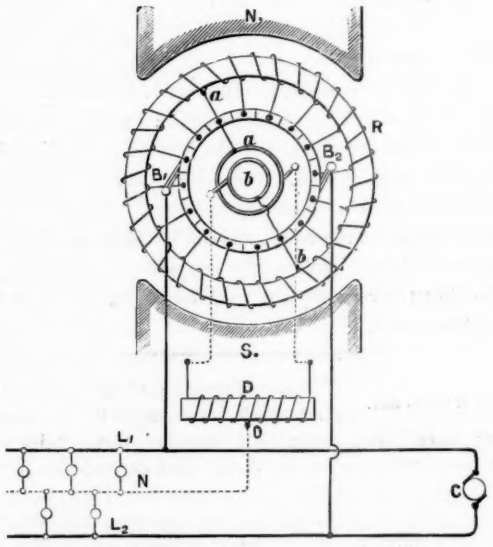


Fig. 3.—Equalising Motor.

This system can therefore be applied to dynamos as to electro-motors, for the equalisers can act sometimes as dynamos and sometimes as motors.

In this article we have only discussed the application of this system to bi-polar dynamos, but of course it can be as readily applied to multipolar machines, in whatever way they may be wound. Moreover, there is no difficulty in grouping these machines in quantity if the consumption of current requires it.

The system we have described will be shown for the first time at the Lyons Exhibition, in the electrical section of the Fives-Lille Company.

COUPLINGS FOR HIGH TENSION MAINS.

The coupling illustrated provides a safe and speedily operated joint for high tension mains, and by its means the latter can be divided into sections, any one or more of which may be isolated from the distributing system without the necessity of stopping the flow of current in the remainder of the main.

The appliance consists of a right and left-hand threaded coupler, for connecting the two ends of the wire cable of the main (the male threads of the coupler being soldered on to the cable), and of a means for insulating and protecting this coupler from wet and damp.

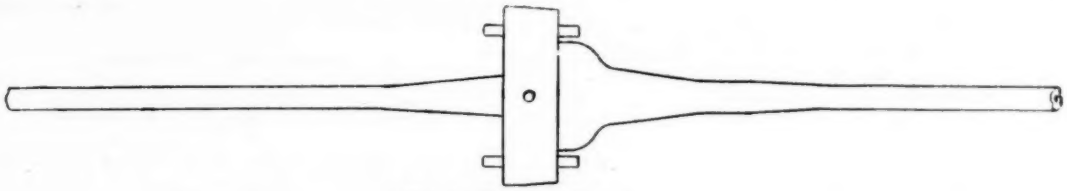


Fig. 1.—Coupling Closed.

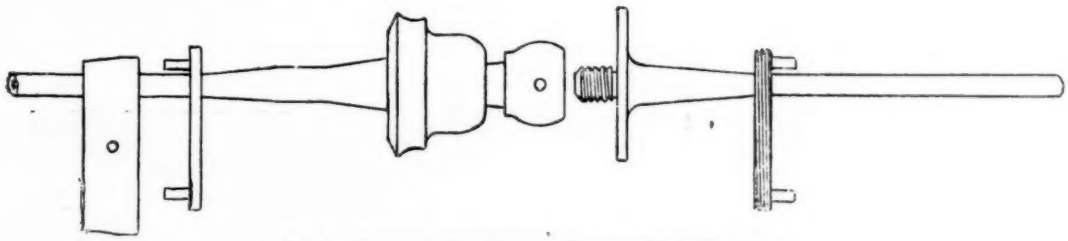


Fig. 2.—Coupling Unscrewed. Ends of Main Uncoupled.

Fig. 2 shows the right-hand screw of the coupler, and opposite to it is shown the nut, which is covered with rubber and which cannot be entirely unscrewed from the left-hand threaded end of the cable.

While the nut is being screwed on to, or off, the right-hand threaded end, the current can pass through the metal of the nut and continue to flow along the cable. The construction of the nut is such that when it is quite screwed up the ends of the cable cannot fail to be pressed closely together, making a satisfactory contact.

The nut, which is circular in shape, has some small holes drilled in its periphery, into which can be inserted the end of a lever (having an insulated handle), for turning and finally tightening the nut.

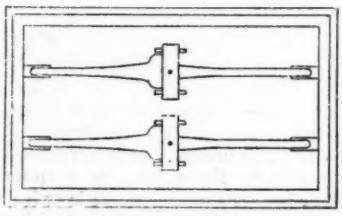


Fig. 3.—Plan of Surface Box, Showing Couplings with Upper Board Removed.

For the purpose of insulating this, which may be called the inner coupler, the rubber sheathing of the cable is formed into a flat flange at one end of the cable, and at the end opposite to the flange into a cup, flanged at its edge, which cup covers the nut and can be turned back, as shown in fig. 2, to give access for operating the nut.

Fig. 1 shows the coupling as it appears when closed for work, the two rubber flanges above described being clamped together by the washers and screwed ring shown in fig. 2, and which form what may be termed the outer coupler.

After the coupling is unscrewed and the cable divided, the end of the "live" main is insulated and protected by an India-rubber "dummy" cup, clamped on to the flange of the half coupling.

The outside diameter of the central ring is about 4¼ inches, and figs. 3 and 4 show the small amount of space occupied by a pair of couplings in a street box about two feet long.

The couplings are supplied, as shown at fig. 1, complete with 3 to 4 feet of cable ready to be fixed to the mains by ordinary joints.

When applied to concentric mains, the outer conductor is stripped back from the end of the main, and twisted into a cable for connecting to the cable attached to the coupling. It is claimed that this appliance soon pays for its cost in the saving in jointing alone, to say nothing of its convenience. Each coupling can be undone in a few minutes.

Several of the leading high-tension supply companies have adopted the coupling; in the case of one company who now have about 80 at work, they have been in use for more than two and a-half years without any sign of deterioration. The makers are the Electric Couplings Syndicate.

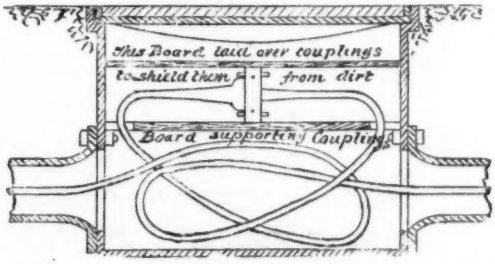


Fig. 4.—Section of Surface Box, Showing Coupling on a Wooden Shelf (which rests on the Heads of the Bolts Holding the Flanged Ends of Pipes), with a Thin Board above to keep off Dirt.

SMALL OR SUB-DIVIDED ARC LIGHTS.

Having recently read a great deal in the *Engineer* about the possibilities and uses of small electric arcs, or the so-called sub-divided arc lamps, says F. B. W. in the New York *Electrical Engineer*, I would like to call your attention to what has been done, and is still being done at present, in this line by the series system, as manufactured and first introduced by the Ball Electric Light Company, of New York City. This company is, I believe, the pioneer in "sub-dividing" the high tension arc light system. The arc as used by them is not sub-divided horizontally by using low voltage, which would have a tendency to produce a poor light, but the quantity of the current passing is divided, and a higher electromotive force is used which has proved to be very economical,

and produces a noiseless and perfectly steady light (except the slight variations, caused by impurities found in the carbons). These lamps run on a constant current of 4 ampères, and each lamp requires from 50 to 53 volts per lamp, or from 200 to 236 watts per lamp. These lamps are guaranteed three to the horse-power, or in other words, they require less than one-third of an electrical horse-power each.

In regard to the candle-power of these lamps, and figuring them in the same proportion as the so-called 2,000 candle-power 450 watt lamp, they can safely be rated at 800 candle-power; the carbons generally used are plain soft, $\frac{7}{16}$ths of an inch in diameter.

The lamp used is a modification of the Ball 2,000 candle-power lamp; the only changes are in the windings of the line and shunt spools and in the adjustment of the lamp; for line wire they generally use No. 8 B. & S.

The generators used for this system are the well-known double armature Ball dynamos (which were fully illustrated and described in *The Electrical Engineer* of Nov. 30th, 1892) and are perfectly automatic in action from one light to the full load of the dynamo, and are built at present in three sizes for this 4 ampère system, viz., 25, 50, and 70 lights capacity each. This sub-divided arc light system has been in successful operation for the past four or five years in various parts of the United States, Canada, Mexico, Central and South America, and has given great satisfaction wherever installed, and nearly 150 plants, supplying upwards of 4,000 of these lights, are in daily successful use.

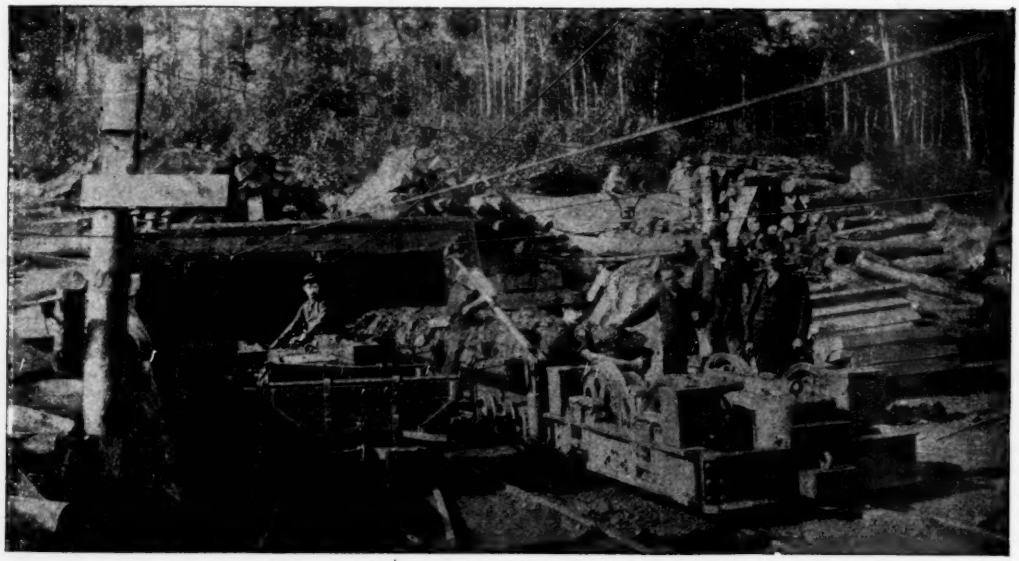
They are giving great satisfaction, especially in street lighting work for villages and towns; these 800 candle-power lamps have frequently replaced 1,200 and 2,000 C.P. lamps for town lighting where shade trees have made economical lighting by arcs of greater or larger candle-power placed at great distances an impossibility, and have also replaced the same class of lamps in cotton and worsted mills, where, by putting in a greater number of these small arcs to thoroughly distribute the light, overcome the shadows from the more powerful arc lamps. They light the premises more satisfactorily and cheaply than either the incandescent system or with arc lamps of a greater candle-power, and at less cost than either of the two methods. One worsted mill in Massachusetts has over 600 of these small arcs in use; another worsted mill in Providence, R.I., has a plant of 400 of these lamps, and the owners say that they are much superior than either gas or incandescent lamps, and answer their purpose better. In street lighting these small arcs have met with the same success, and for towns and villages having shaded streets they offer the best and cheapest method of lighting so far devised, and they have replaced several incandescent street lighting plants.

One of the most recent plants of this type has just been installed for the Jamaica Electric Light and Power Company, of Jamaica, N.Y., and consists of two dynamos of the G 4 type and 140 all night single carbon Ball lamps, using a plain $\frac{1}{2}$-inch carbon, and giving a run of from 15 to 16 hours, without recarboning.

I would certainly advise any person having any doubts about this system of street lighting for small towns and villages to pay a visit to Jamaica and see for himself what can be done by a small sub-divided high tension arc system. I would like also to state here that the Ball Company still continue to manufacture their old standard 1,200, 1,600, and 2,000 candle-power arc systems, and they have recently greatly improved their apparatus in electrical and mechanical details.

ELECTRIC HAULAGE PLANT.

CONCRETE examples of the adoption of electricity to the exclusion of all older methods are generally more convincing in their import to the public mind than mere heresay or description. The illustration shows the supersession of older haulage methods by the electric mine locomotive in an important coal mine in Pennsylvania, and emphasises the vast advantage which its use confers.



The mine in question is the Bear Run Mine of the Blossburg Coal Company, near Landrus, Tioga County. The locomotives, of which there are two, are of the T.M.M., that is, "two-motor mining" type, each of 30 horse-power, manufactured by the General Electric Company. They are propelled by two W.P. 30 motors, one being geared to each axle. Current is brought to the motors by a specially designed trolley arm, on which the trolley wheel is swivelled, to permit of its adjustment to the various irregularities of the wire line. The trolley arm can be set in sockets on either side of the locomotive, which may thus be run into headings on either side of the main haulage way, which is lighted by incandescent lamps placed at the entrance to each cross-head, 100 yards apart. The dimensions of the machines are: horse-power, 30; speed, 6 miles per hour; draw bar pull, 1,500 lbs.; gauge, 36 inches; wheel base, 30 inches; diameter of wheels, 28 inches; width over all, 48 inches; length over all, 9 feet 6 inches; height above rail, 31 inches; weight, 7,500 lbs.

The current is furnished by a General Electric D 62, 75 horse-power generator driven by a Harrisburg Ideal 80-H.P. engine.

The maximum load which these locomotives have been called upon to handle is 32 loaded mine waggons, each weighing 3,200 lbs., and the way is in one part a 3 per cent. grade. The daily haul of the locomotives is about 650 tons.

The entire plant has been pronounced eminently satisfactory, the locomotives having shown capabilities beyond the specification or the General Company's guarantee. Their presence in the mine has done away with the slow going limited mule, and induced great economy. The small height of the machines above the rail level allows them to run into places impossible to any mule, and their ease of control and operation is such as to render them invaluable.

PROPOSED CABLES UNDER THE PACIFIC.

In a recent number of the *Engineering Magazine*, Mr. Herbert Laws Webb discusses the question of proposed cables under the Pacific Ocean :—

There are really two distinct schemes on foot for cables across the Pacific : one, which may be called the American plan, for a line from California to Japan, *viâ* the Sandwich Islands ; the other, which may be called the British-Canada-Australian plan, for a line from Vancouver to Australia, *viâ* the Sandwich Islands, and the Fanning, Samoan, and Fiji Islands.

The two schemes, in all probability, will both be carried out, thus giving a duplicated link. A single line over such an extremely long route as 7,000 miles long could never be permanent.

Mr. Webb shows that from every point of view the Imperial route is the most attractive one. Apart from the question of joining the colonies together, it has the distinct advantage of containing a greater number of sections, which renders the line easier to operate and also gives greater opportunities for picking up traffic and subsidies. The Imperial route has five sections, none of them of extraordinary length. The American route has only two sections, one of which is of extraordinary length. The section from Hawaii to Japan will be over 3,400 miles long—nearly a thousand miles more than the longest of the Atlantic cables. Such a long cable would be expensive to operate, as the transmission would be comparatively slow, and interruptions would be very costly, because the delay in effecting repairs would necessarily be great. Another difficulty is that the bottom of the ocean off Japan has a bad reputation, though possibly this will disappear before the light of a detailed survey.

A great deal of nonsense, says Mr. Webb, is written about the "strategic" value of a direct line between Canada and Australia. It is nonsense because, without a line across the Pacific, there is excellent telegraphic communication between Downing Street and Canada and between Downing Street and Australia, and when Downing Street wants to telegraph there is no anxious consultation of the tariff-card to see how much the rate is.

The length of cable necessary to construct a line from Vancouver or Monterey to Brisbane is, in round figures, 7,500 or 7,000 miles—the higher figure for Vancouver, the lower for Monterey. The lowest price at which an Atlantic cable has been laid is about $1,000 a mile. To lay cables across the Pacific would cost rather more, on account of the greater distance from the seat of cable manufacture. The capital necessary for a single line, therefore, would be nearly $10,000,000, and, with duplicate sections, without which the venture would be of a most uncommercial nature, nearer $20,000,000.

It is an unquestionable fact that submarine cables, like long-distance telephone lines, make their own traffic by creating new ways of doing business. In the case of the Pacific cables, the places now without communication that will be opened up are of relatively insignificant resources, excepting Hawaii, and even Hawaii in ordinary times will not keep a cable busy all day. But in the aggregate the different intermediate points will probably make a fair showing, and, whatever traffic they furnish, will surely show a steady increase.

The Pacific cables, however, will find their principal traffic through providing a more direct route between Australasia and the American Continent. There is already considerable trade between this country and Australia, China, and Japan, and more direct communication cannot but give that trade a great incentive. Cables connecting America with Australia and Japan will give her quick communication besides with the Straits Settlements, the Philippines, China, Siam, Tonquin, India, and Asiatic Russia. They will provide an alternate route from Great Britain to the extreme East and Australia, and other sources of traffic will be found in Canada and South America. The completion of the trans-Siberian Railway, opening up communication across a vast tract of most varied resources, will introduce an important change in the channels of commerce in the part of the world that the cables will draw on for their traffic.

The profiles of the Pacific from California to Hawaii that accompany the elaborate report of the United States survey show a bottom that is a delight to the submarine cable engineer ; all he could wish is that the whole of it were a little nearer to the surface.

THE ELECTRIC STATION OF THE CITIZENS' LIGHT AND POWER COMPANY OF ROCHESTER, N.Y.*

By ROBERT CARTWRIGHT, M.Am.Soc.C.E.

The inventions and improvements in electrical science at the present day are so rapid and comprehensive that a very little time makes great changes in the development of the machinery and the application of electricity to many new channels of industry. Already has the small steam engine been relegated to "innocuous desuetude" by this unknown but potent agent, because of the readier application, cleanliness, and economy of the latter. The day cannot be long delayed in this progressive age when the generation of electricity by hydraulic power and its conservation in a transportable form will effect a revolution in many of its present objectionable features, and we shall see the expensive copper wire at least restricted in its use, if not entirely displaced by storage, in a practical and economical manner. Do we not have energy of almost infinite capacity concentrated in the form of gunpowder, dynamite, nitro-glycerine, and many other kindred compounds, and is it expecting too much of the inventive genius of this inventive age to confine this subtle power, so that we can release and utilise it at our will ? "'Tis a consummation devoutly to be wished" that some Edison or Tesla, some Thomson or Julien, will produce it from the combustion of coal, without the intervention of engine or boiler, water-wheel or dynamo, as an intermediate part of the plant. What electricity is, we know not. Its effects and its affinities comprise the sum total of our knowledge. Its development, instead of being the result of studied theoretical laws, is almost entirely experimental. The telephone and phonograph, the dynamo and transformer, are all the products of experimental research. Their inventors did not know what they sought, until, like Pandora opening her box, they released a series of perfected, though previously unknown, results.

The consolidation of the three gas companies and the three electric companies of Rochester, N.Y., into one organisation, known as the Rochester Gas and Electric Company, was effected in 1892. This combination seems to have awakened in the mind of some of Rochester's citizens the old saying that "competition is the soul of trade," and hence the birth of the Citizens' Light and Power Company. Some of the stockholders in the different companies sold out their interests when the consolidation was entered into, and organised an independent company, whose plant, designed and constructed by the writer, is in operation, supplying electricity for light and power. Its equipment is of the latest and most improved machinery under the Westinghouse system. As the work embraces some interesting features, a description of the power plant in detail is furnished.

The city of Rochester, N.Y., is almost evenly divided by the Genesee River running through it from south to north, and having within the corporate limits of the city a total fall of about 257 feet, in a succession of three falls and rapids. The water is used over four times before it reaches the level

* Read March 7th, 1894, before the American Society of Civil Engineers.

of Lake Ontario. In former years when the drainage area of the country supplying the Genesee with water was covered with forests, the flow was constant and reliable, but to-day an advanced civilisation has cleared off the land, and the consequence is that a dependence on the river, as a means of supplying power, is very irregular and uncertain, almost realising the old adage of "a feast to-day and a famine to-morrow." This has become so unsatisfactory, that the city's interests are jeopardised by it, and measures are now being taken to store the water, at a point near Mount Morris, by damming it back in the ravine to the south. A bill is now being considered in the State Legislature, looking to this end. As the State of New York has the first right to the water of the Genesee, or so much thereof as is needed for feeding the Erie Canal, at times of drought in the summer the volume reaching the city is sometimes only 4,000 cubic feet per minute, as per the gauging records of E. Kuichling, M.Am.Soc.C.E., and Chief Engineer of the water-works. This, divided among the many industries dependent upon it, becomes practically useless. By impounding the water, as stated, the amount confined from melting snows and heavy rains would be dispensed at Rochester, so that a constant power of 30,000 H.P. per day would be realised, instead of passing through the city at times of freshets entirely unused.

In the opinion of the writer there is no other public improvement that will inure to the benefit of Rochester so much as the storage of the water of the Genesee. Parks and boulevards may easily wait until the utilisation and application of all of the water of the river will so enhance the position of Rochester, as a city of reliable and cheap water power, that manufacturing capital will find a desirable investment in it, and fill the entire ravine below the falls with hives of industry which, in a very short time, would enable the city to adorn itself without the imposition of onerous taxation.

The fact of water storage in the near future being a possibility has been considered by the writer in designing the power station, so that advantage may be taken of it, when realised, without unnecessary change or expense. By reference to the accompanying plates, the location, disposition and construction of the work will be readily understood.

In August, 1892, the Citzens' Light and Power Company acquired the property now occupied by its station on Brown's Race, at the Foot of Factory Street. Nothing but a mass of ruined walls and débris gave evidence of its having been previously occupied. The site was that where once stood the Jefferson and Clinton Flouring Mills, which were destroyed by fire under such peculiar circumstances that the writer may be pardoned for a narration of them.

Fig. 1 shows a plan and sectional elevation of the property at the time of its purchase by the Citzens' Light and Power Company. As will be seen, a main sewer traverses the whole length of the Jefferson lot from Mill Street to the Genesee River. The sewer was 6 feet by 6 feet in size, and was cut under Brown's Race by tunnelling the rock some 20 feet below the race bottom, the lower portion built on the rock slope and covered with earth. On December 21st, 1887, the Municipal Gas Company, whose property was on the line of said sewer about 3,500 feet distant, was being supplied with naphtha by the Vacuum Oil Company through an underground pipe connecting the two properties. The naphtha was forced by pumps to a tank at the gas works. A short time prior to the delivery of the last large supply of naphtha, the connecting pipe was broken at an undiscovered point in the vicinity of a rock excavation adjacent to the line of the aforesaid main sewer, and about 15,000 gallons of the naphtha was pumped into the sewer instead of being delivered into the tank. The naphtha was carried along on the sewage until the whole length of the sewer to the outlet at the river was charged with its vapour. By some means fire was communicated to it through an untrapped lateral sewer, and an explosion occurred that blew up the Jefferson Mill, as well as many of the manholes along the line of the sewer, the flames at every point of issue rushing out to a height of 30 to 40 feet. The resulting fire destroyed the Jefferson Mill, as well as the adjoining Hinds Mill, leaving them in ruins, as well as causing the loss of five human lives. The Clinton Mill had been burned down some time previous. The Hinds Mill was rebuilt in 1888, but the others were as left by the fires when the Citizens' Light and Power Company purchased the property. This was the condition of things when the writer was called on to plan an electric light station.

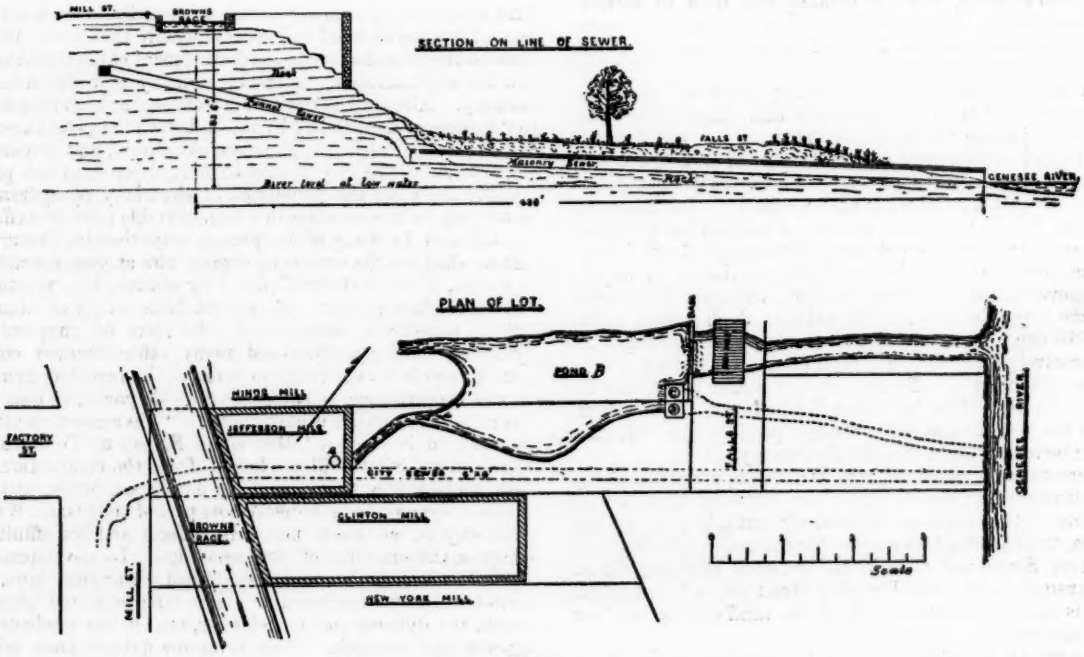


FIG. 1.

The Jefferson Mill had two water-wheels located near A, fig. 1, operating under a collective head of 56 feet. The discharge from these wheels, as well as that from the Hinds Mill, ran to the pond, B, which had a dam at the west side of Falls Street. The water from this pond was used on the two wheels, C and D, with a head of about 25 feet, power from these lower wheels being transmitted to the Hinds and Jefferson mills by means of wire rope.

After due consideration of all the essential features, the plan as shown on fig. 2 was decided upon, the whole station being placed below the side of the mills upon what was considered almost useless land. As the race front was the portion that gave value to the property, the company possesses the same race frontage intact, while it has acquired a complete power station besides. Work was commenced on November 28th, 1892. As the discharge from the sewer was continuous, and

had to be maintained while the work was being prosecuted, the first step taken was to direct the sewage water into the pond, B. This was successfully done by a large wooden

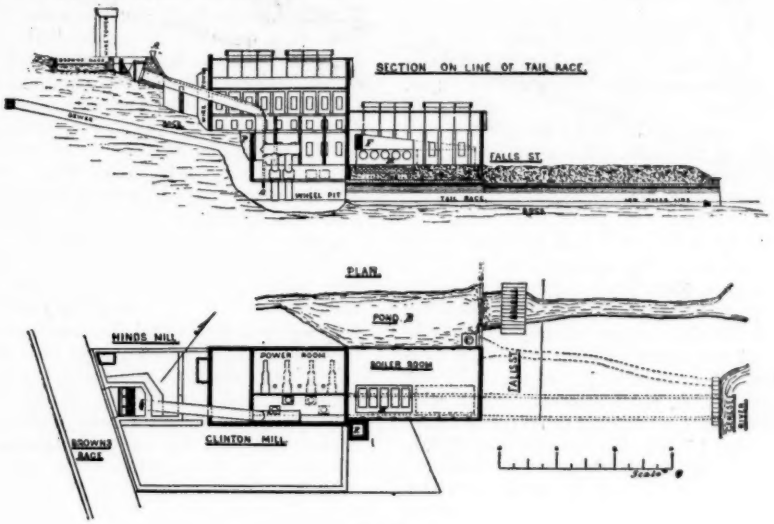


FIG. 2.

trough placed at such a point in the sewer as would pass the water by gravity into the pond, B. A coffer-dam of sufficient dimensions and height was placed at the river end, so as to shut out the river water in its various fluctuations. Steam

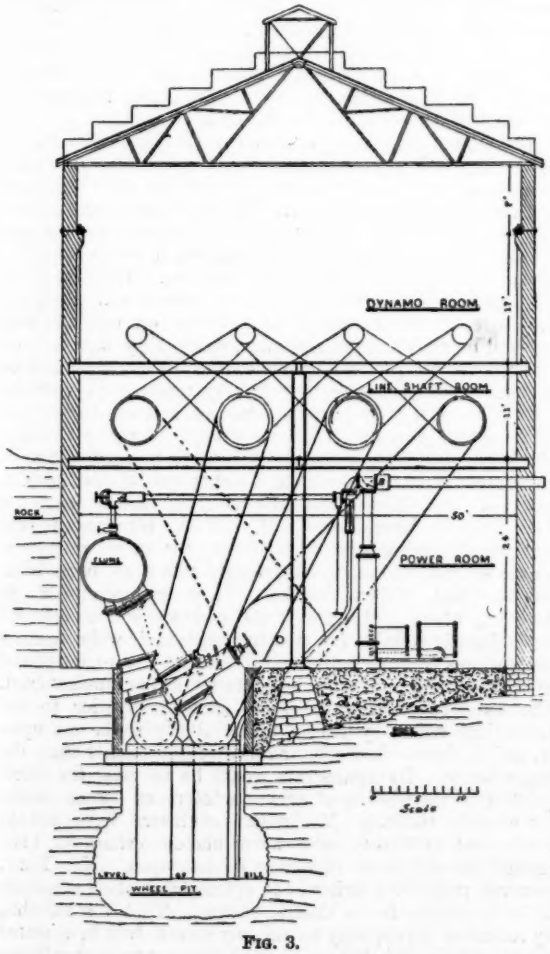


FIG. 3.

pumps kept the water down, so that the rock at the lower end was bared, and upon this the masonry of the side walls of the tail-race was commenced, and carried up to 6 feet above low water mark of the river. The race was made 13 feet wide in the clear. An arch of 7½ feet internal radius was thrown across the top. The rock was excavated in the centre of the race 2 feet below the low water mark, which was considered the datum point of the whole work. This construction was carried out in open cut (the old sewer being removed as the work progressed) to a point coinciding with the west side of Falls Street, a distance of 165 feet from the river face of the tail-race. Here a change was made, making the arch semi-circular, with an internal radius of 6½ feet. This was done in order to better support the superincumbent weight of steam boilers that were placed directly over the tail-race, as shown on fig. 2. These dimensions were maintained for a distance of 95 feet west of Falls Street, making a tail-race proper 260 feet long. At this point the wheel pit commences. The side walls of the race are built 2 feet thick, and a skew-back placed 6 feet above the datum line to receive the arch, which was also 2 feet thick. The face of the tail-race masonry at the river end is rock-faced, and is carried up above the top of the arch and covered with point-dressed coping stone. At the inner end of the tail-race, adjoining the wheel pit, is placed a level sill or spill, whose top is 1 foot above the datum, to maintain a seal of the draft tubes of the water-wheels. The wheel pit was enlarged by under-cutting the rock, as shown by fig. 3, and deepened, so that its bottom is 6 feet below the bottom of the draft tubes. This gives free discharge to the water from the wheels and prevents any reaction. The pit is 64 feet long, and on the wheel floor is 14 feet wide in the clear. The wheels are supported on double 16-inch steel I beams, resting 2 feet in the rock at the ends, in recesses cut therein. Above the wheel floor the pit is lined with 12 inches of brickwork on the sides. The ends of the I beams are solidly built up with brick, filling the recesses. The wheel floor is laid with 2-inch matched and surfaced hemlock plank. Upon this at right angles to the plank is laid 1¼-inch planed and matched hard maple flooring, with a layer of asbestos flooring paper between the two. This was done in order to cut off any possible odour arising from the sewer. The wheel pit floor is 15 feet 3 inches, and the power-room and boiler-room floor 25 feet above the datum line.

By March 8th, 1893, the tail-race, wheel pit, and the foundation of boiler house were completed, and the sewage was turned into the wheel pit. All of this masonry was laid in American Portland cement, of the Columbia brand. The work was prosecuted continuously, excepting Sundays, during the whole of the cold winter of 1892-93, the temperature being as low as — 6 degrees Fahr. at times. But one half day was lost during the whole time, when a sleety rain that froze as it fell rendered it impossible for the men to retain a foothold on the work. All the mortar was salted to prevent freezing. The foundation of the buildings and chimney are all upon the rock, with the exception of a short space where the water-wheel, D, fig 1, had been removed.

On March 16th the brickwork of buildings and chimney

was commenced. The walls of the boiler house, as well as the chimney, are laid in quick-lime mortar, but all the rest of the whole work is laid in cement mortar. For the main building the walls were laid as follows :

An inside and outside course of wall was laid two bricks high, then the centre of the wall was filled with grout and the bricks placed in the grout, the bricks having been previously wetted. Headers were introduced every seven courses, and alternated on the inside and outside of the walls. All bricks were hard-burned sewer bricks, and joints were struck on the inside and outside of the walls. When completed, the inside faces of all the rooms were painted with white Aquol paint. The walls of the boiler house are 12 inches thick, and reinforced on the inside by 4-inch pilasters, 16 inches wide, placed immediately under the roof trusses, spaced 10 feet 4 inches apart, centres. The walls are 24 feet high to the eaves, with a gable on Falls Street.

The walls of the main building are 59 feet high from foundation to eaves, divided into a power-room 24 feet high, and a line shaft-room 11 feet high. To this height the walls are 2 feet thick. At the floor of the dynamo-room the wall is reduced to 20 inches thick, and reinforced on the inside with 4-inch pilasters 20 inches wide, spaced 10 feet 4 inches apart, centres. At a point 17 feet above the floor the bricks are corbelled out, joining the pilaster heads and forming a bearing for a line of 8 × 8-inch white oak stringers, which are bolted through the walls, to carry an overhead travelling crane. Above this the walls are carried up to the eaves, 20 inches thick.

The buildings are covered with steel trussed roofs, having a rise of 13 feet in the centre. Principals are spaced 10 feet 4 inches apart, centres. Span of dynamo room, 50 feet; and of boiler room, 48 feet. Each roof has two ventilators, for light and air, which are about 30 feet long each. Upon the trusses steel purlins of 6-inch channel beams are fastened on edge. To the web of these purlins are bolted 2 × 6-inch stringers. To these are nailed the roof boards of $1\frac{1}{8}$-inch flooring, and the whole covered with sanded tar roofing paper.

As the sides of the Jefferson lot are not parallel, being 50 feet wide at Falls Street and only 48 feet 9 inches wide at a point coinciding with the west end of the main building, an agreement was made with the Hinds Mill Company to place so much of the building upon their property as would make the buildings parallel. As a consideration therefor, a party-wall interest in the north wall of main building was given them. By this arrangement the roof trusses were uniform, and the result was a considerable saving in the cost of roof construction.

A chimney is located as shown at E, fig. 2, into which are carried by the smoke jack, F, the smoke and gases from the batteries of boilers. The chimney foundations are on the rock. It is 14 feet square at the base, and is carried up 125 feet high, with a straight flue 8 × 8 feet.

As soon as the season was advanced far enough to preclude freezing, the space in the boiler room over the tail-race was filled and solidly rammed down to a depth of 6 feet below level of floor, and a solid foundation of rubble work, laid in cement mortar, was built to receive the boiler setting for the first battery of five boilers as shown by fig. 2.

(To be continued.)

COST OF ELECTRICAL ENERGY.

By W. H. BOOTH.

II.

Before going further into the question of the Wigan trials, it may not be out of place to refer to Mr. Tozer's letter of inquiry in the Electrical Review of May 18th. I could not, of course, be aware, not being present at the reading of Mr. Crompton's paper, that the author of it had to some extent receded from the position he had taken up. The amount of the retractation was, however, so small, and was accompanied by so many reservations, as to make it of no account whatever, so that even had I heard the admission it would have made no difference in my criticism. Taking first, however, the added remarks, it may be said that every boiler needs care and watchfulness, and no boiler can be fired heavily without care, except, of course, with smokeless coal, which any fool can throw on and therewith make no smoke. Mr. Crompton clearly grudges a decent wage to a fireman. This is a question, perhaps, a little outside the argument, but I have always been taught to understand that the bulk of all business arises from purchases made by the working class, who form the majority of the world's consumers. Who, then, could be purchasers on the grudged wages rates of Mr. Crompton, who ought to know that there is a large and, I fear, a growing class that considers that poor men like the writer, stokers, editors, and others, would be better able to indulge in the electric light, for example, if manufacturers of electric appliances would limit the present large profits that enable them to roll through the world in cabs and luxury, and be content to tramp in high-lows and fustian, to which state indeed they will certainly come unless they see to it that would be consumers are allowed the power to consume. Mr. Tozer says that my criticism does not affect Mr. Crompton's conclusions as first expressed. It does so affect them nevertheless, for Mr. Crompton denied that the hydrogens of bituminous coals could be utilised; he denied the good efficiency of Lancashire boilers, and the value of the economiser in other cases. The object of the criticism was not to prove the Lancashire boiler better suited to an electrical station than is any other form of boiler, but to point out that statements had been made at variance with proved facts. The figures already given as to the combustion rate at the Wigan trials fully support this. The coal consumption of 27 lbs. per foot is probably a good deal higher than in most boilers using chimney draught, and quite high enough to take the sting out of the statement that Lancashire boilers cannot be forced. The reduction of the main flue temperature almost to that of the steam temperature is, when expressed in its electrical parallel, about equal to putting a resistance of x into the circuit of a dynamo, and passing the current with a difference of potential on the terminals of the dynamo of such voltage as ordinary electricians find insufficient to overcome a resistance of x.

The reduction of waste temperature is what economisers are for, and it is obvious that no boiler worked at a high pressure can be economically worked without an absorbing surface for low temperature heat. The water tube boiler has not this surface, nor is it desirable that it should have. It is also claimed to have a good circulation, which would imply an absence of any lower temperature surface. With many of the long flaming bituminous coals the flames will easily extend three times the length of a boiler, or, say, 90 feet, and will be visible in the main flue, where they can be seen through the dampers of any one of the boilers that may be at rest. These flames are burning hydrogens, and must be proof that such gases have been burned, and can be utilised. There is always a doubt of the wisdom of using a boiler which can only burn one coal. What can be done in case of a strike? Were Welsh coal to be shut out of the market, most of the London electric stations would have to stop or use bituminous coal. With bituminous coal they would inevitably produce smoke, for these water-tube boilers are not, and cannot be, readily suited to burn bituminions coal without smoke. They were designed in America, where anthracite is the common steam coal, and are eminently suitable for such fuel, with their wide furnaces and surfaces of impact, but such limits are not to be placed to the powers of an electric light station as are thus involved. The water tube boiler has been claimed superior to the Lancashire boiler by reason of its ability to be set up—or, rather, down—in a cellar so much more readily than the larger boiler. To discuss this would be to raise the whole question of the wisdom of such engineers as choose cellars for electric stations. Mechanical engineers have always condemned architects who have chosen cellars as good enough for boilers, so this may be left open. Mr. Tozer, however, asks if the writer is of opinion that the Lancashire boiler is suitable for an electric station. That it is suitable, by reason of its capacity to use any sort of fuel is, as stated above, certain, and there is no good reason why it should not be suitable on other counts. Some years ago, when the Galloway boiler was being pushed, it was the fashion to claim for it a superior efficiency, because it could raise steam quicker than a Lancashire boiler. No notice was taken of its

smaller contents of water. The water-tube boiler must also be a quick steamer as compared with a Lancashire boiler, because it has small water capacity; but a small water capacity argues an unsteady steamer, and one from which a sudden demand for more steam must be responded to by a direct effort of the furnace, and this is the sort of thing that keeps the fireman always on the hop. One thing is certain about an electric station, there must always be boiler-power sufficient for the maximum output, whatever class of boiler be employed. The leader in the Electrical Review of May 18th, quoted figures of tests which showed that a very wide range of duty could be covered with Lancashire boilers without diminution of efficiency, and it is well known that mill boilers will remain closed down for hours with little loss. Taking into consideration this wide limit of efficient working, and the fact that no central station is worked without being prepared to spring into a very full state of activity on a moment's notice, it is not unreasonable to pay very little attention to the assertion that the large water capacity of the Lancashire boiler is responsible for heavy loss. Even such loss as there may be will be balanced by the power it possesses of running the fires down, when nearing the stopping hour, much lower than can be done in a boiler of less staying powers—of less storage capacity. In a well designed battery of boilers there is not a large area of radiating surface. The boiler crowns are well protected, and the brickwork is made impervious to air; the dampers are closely fitted and the fires may even be kept alight, though scarcely recognisable as alight, and ready to be quickly rendered active.

Excepting within reach of Welsh coal at fairly local prices, it appears that there are no reasons to doubt that, economically as well as prudentially, the boiler that can burn any fuel will do the work of an electric station better than the boiler which demands one fuel at a high price. There is no better coal than best Welsh, but its London price puts it out of the market as compared with some other fuels. The article above referred to, shows this very clearly, and it is very poor commercial engineering to throw away money in fuel rather than face the problem of smoke prevention, and to mortgage the future in respect of a fuel that may not be at hand when wanted. As regards forcing a boiler, a Lancashire boiler can be forced equally with any other form, as witness the Wigan tests. But the mistake must not be made of forcing bituminous coals entirely by ashpit pressure, for smoke must inevitably be produced by such a system with bituminous coal. There must be provision for supplying air above the fuel, and this cannot be done when the chimney is insufficient in area. An insufficient chimney may be made to swallow what is forced upon it, but is not easy to work, and the guess may be hazarded that too small a chimney area is responsible for smoke in many cases, but this is, after all, mere evidence of bad design. There is a den (no other term is so applicable) not a hundred miles from Charing Cross, where a marine type of boiler was put in in preference to a Lancashare, presumably as being self-contained. This boiler made (probably still makes) the station simply unbearable, and if it is evidence of improvement on the fossil Lancashire, it is very poor evidence indeed to set against what is called the "complication" of external flues. Mr. Crompton's assertion as to the seeking for economy being so marked where fuel is dear, has already been referred to, but it may be still further contradicted for many London stations by calling attention to the entire neglect of condensing with water close at hand. The independent condenser, and the—but here I might be grinding my own axe, and I will content myself with simply emphasising this contradiction. In the discussion upon Mr. Crompton's paper, Mr. Geipel covered much ground I should have liked to have covered, and his reference to the by-pass flues for keeping warm the boilers that are at rest is specially to be noted. This method of consuming heat or replacing radiant loss is much to be commended, and is one not so readily applied to boilers without external flues.

A deal of nonsense has, however, been from time to time written concerning the great absorption of heat by brickwork. Bricks have a specific heat of about 0·2 only, and if protected against losing this, as already explained, there is no reason for any special loss. Absorption of heat is not necessarily a loss. For burning lump coke the Lancashire boiler is not suited. Coke is a fuel that is so open that it must be fired deep, and if it must be burned in such boilers it should be broken to walnut size. The deep locomotive type fire-box ought to burn coke with good results.

The mechanical stoker has been referred to by me as a smoke preventer when of the coking type. Many people have tried mechanical stokers and they have failed with them, and very properly so, under the conditions attempted. A mechanical stoker ought to save labour. Usually it more than doubles the labour, involving as it does the overhead filling of the coal hoppers more than doubly as high as the firegrate, and smothering the stoker in dust. Where is the labour saving in this? With proper means of filling the hoppers as now sometimes arranged, a coking stoker will feed and burn coal at a good speed per foot of grate surface, and will do it smokelessly, because the feed being regular the air adjustment can also be regular.

The argument that high class boilers are apt to give poor results when badly looked after is not very convincing. As well reduce all steam engines to the simple slide valve type with steam at 15 lbs. pressure, in order that there may be no need to pay other than the lowest wage to the attendants. A stoker has as great a right to be intelligent as any other class of men, and I have found that good men exercise their intelligence. Only a few days ago, in a Yorkshire boiler house, the fireman explained how, with two coals with which he was supplied, he found it to be advantageous to work one very much thicker at the bridge than he worked the other. This was purely a matter of observation, and may have been as much a feature of the boiler as of the fuel; but it is evidence that stoking ought not to be looked on as so much coal shovelling from one heap to another. It is not thus considered by many large coal consumers, which may account for the results they obtain in everyday work without constant supervision of their firemen. Seeing that an electric station manager is always endeavouring to increase the day load, we may take it that with means of burning coal at a 30-lb. rate in passing the peak of the load diagram, and with a capacity to secure efficient work at low rates of combustion, there is not the same need to shut down the boilers as soon as the load drops as there is to stop an engine. The boilers can be worked until the combustion rate falls quite low, and if there be still any fear as to the large amount of hot water standing at rest, provision can be made to feed the working boilers from those at rest, filling these up with water from the feed heater. In any case, we may suppose that no matter what the type of boiler, the water level should be reduced towards the end of a run, and filled up with the fresh feed, if only to avoid excess of pressure.

In a future article I propose to give a further analysis of some of the Wigan tests.

ELECTRIC TRACTION.

Since reviewing Prof. Kennedy's address to the Mechanical Engineers, we have read the comments of several electrical engineers who have aired their views in the pages of a contemporary. The address seems to have aroused a considerable amount of adverse criticism on the remarks made by the professor on the trolley wire system of traction, and on the efficiency of electrical traction in general, which he placed at the low figure of 35 per cent. We previously acquiesced in this estimate, and the discussion has not altered our opinions. In fact, if electrical engineers cannot advance more convincing proofs of a higher efficiency for electric traction, they had better adopt the professor's suggestion and confine their attentions to electric lighting only.

The truth is often unpalatable, but when it is ignored by engineers, very serious consequences arise; hence we approve of its publication so that they may be brought to look the problems squarely in the face. We unfortunately cannot find data regarding electric traction on any large scale at home, but in America there is abundance of experience and actual published results upon which perfectly reliable estimates may be made. And it is becoming more and more forced upon the electric railway engineers on the other side, that withal the rapid and gratifying extension of electric traction, there is still very much room for improvement; in fact, unless something

is brought out to meet some of the most obvious difficulties, further extension will be much impeded. It is not little detail improvements which are required, such as improved gearing between the motors and car axles, or improved motors. American capital and engineering skill has been lavished without stint on details of that kind, and they may be said to have arrived at a knowledge of the best gearing and motors for the purpose of electric traction as carried on in existing railways. With high efficiency generators, motors, and gearing, still there is a heavy loss to account for, and if possible, to provide against, so that this loss must be in the system if it is not in the generators, motors, or gearing. The difficulty is fully recognised, although little understood, especially on this side, where so little practical experience of electric traction exists, compared with that across the Atlantic.

On this point we may quote from a report of the Railroad Commissioners of Massachusetts, February 7th, 1894, referring to the trolley system :—

"During the year there has been an increase of 214 miles of trolley electric roads, and £5,000,000 invested." But "It can and should be said, without hesitation or qualification, that the electric system has not shown or indicated any such margin of profit as to justify more than ordinary and moderate returns on money legitimately invested in it. The absolute cost and expensiveness of the system are sufficient to tax its earning capacity to its full limit. There is no margin for inflated or fictitious capitalisation."

We quote another American authority on railways, General Hermam Haupt :—

"Where steam can be used as a motor, electricity generated by steam cannot be employed (by present methods) economically for car propulsion—the great field for electricity is electric lighting. It may also be advantageously used for transmitting power long distances from water-falls, but for the propulsion of cars and trams on railroads it must eventually give way to compressed air unless greatly improved."

While these views agree with Prof. Kennedy's on electric traction, the general is quite opposed to the professor's views on other mechanical motors.

He continues : "Gas motors have exploded and burned up. Cable lines can only be operated on long lines of straight track, and then only when there is a 'magnificent business.' Steam is intolerable ; carbonic acid gas and ammonia are impracticable."

As to cost, General Haupt arrives at the comparative cost of electric, steam and compressed air traction, by elaborate and careful calculation, as—

Electric traction	$397.20
Steam...	584.22
Compressed air	240.66

These figures are for railways in Chicago. In New York the comparative costs are—

Electric...	$344.75
Steam	392.22
Compressd air	192.66

Again, in *Engineering*, May 11th, C. S. D. Riche Preller in a letter says :—

"Prof. Kennedy's contention would have some foundation if, instead of compressed gas motors, he had shown a predilection for compressed air motors." "There are within my knowledge at least eight electric railways where the total average efficiency ranges from 65 to 72 per cent."

Now, from all that can be gathered on the subject, we are convinced that Prof. Kennedy's estimate is nearer correct than any made by his critics. Let us look at his figures, and let any of his critics point out any one item which in general practice is too low an estimate. This is how the professor gets his 35 per cent.

	Per cent.
Mechanical efficiency of engine	85
Efficiency of belt-driving (if employed)	94
„ of dynamo	90
„ of line	85
„ of motors	85
„ of gearing on locomotives ...	75
Total efficiency ...	39 per cent.

From this is to be deducted, say, 10 per cent. for driving the locomotive, leaving 35 per cent. for pulling the train.

Belt driving is not now adopted, so that 6 per cent. is saved on this estimate, and in some railways no gearing is used on the locomotives, so that another 25 per cent. is thereby saved ; but gearless locomotives are necessarily large power motors, so that in general it must be admitted that loss in gearing must be allowed, and over all, perhaps, 75 per cent. is not too low an efficiency for gears usually employed on street railway and other small power locomotives. On the other hand, the efficiency, 85 per cent. of the motors, is far too high an estimate ; no electromotor on a locomotive can possibly give an average efficiency of 85 per cent., if the speed of the motor varies with the speed of the locomotive, and is controlled by a rheostat, as is the usual practice. It matters not whether the motors and generators are series, shunt or compound machines ; there is only one speed—a high one, too—at which this efficiency could be attained. The loss in the rheostat and in the motor at slow speeds, and at starting up, is very great, and, in practice, the average efficiency of the motors is thereby reduced to less than 50 per cent., taking the work done and the total watts expended in doing the work, into account. Of course, if we take the watts lost in the motor only, some of the high estimates of the efficiency may be accounted for, but these estimates are misleading ; to be accurate, we must include the watts lost in the rheostat and regulating devices. It is a difficult matter to measure the efficiency of electric locomotives practically by any direct method ; but their inefficiency cannot for a moment be doubted by anyone who has had an opportunity of studying the engines and generators in a power-house supplying electrical energy for a large system of electric railways such as are to be found in America. The average power sent out per car for a street railway is 10 to 12 H.P. for cars which could easily be drawn at the same speed by three or four horses.

All this may seem, on our part, to be terribly pessimistic, but the persistence with which engineers press the claims of electric motors and traction, and as persistently blink the facts, calls for some comments, if only for the purpose of turning attention to the need for improvement.

Compressed air seems to be the only rival to the electric motor for street railway work, so far as general adaptability is concerned. The authority previously quoted—General Haupt—gives the coal consumption as :—

Steam = 96 tons. Electricity = 120 tons.

Compressed air requires 48 tons of bituminous and 12 tons of anthracite coal for the same work done, showing considerably in favour of compressed air. The compressed air locomotive is, however, much heavier, power for power, and as presently employed must carry a store of air sufficient for each journey, coming back to the power-house at regular intervals for a fresh supply ; it is, therefore, limited to short journeys from 8 to 10 miles or so.

We have already reviewed Mr. Leonard's method of regulating electric locomotives, which has for its object the saving of the great losses arising out of the variable speed and rheostat regulation. It can be said of it, that it is a rational method, but that cannot be said of the many proposals made with the same end in view by would-be inventors who suggest some kind of variable speed gearing between the motor and car axle. Every conceivable kind of mechanical variable gears has been suggested, and most of them have been actually tried, but without success ; in fact, such gears are worse than useless. Not only do they not accomplish the desired effect, but their efficiency is extremely low, they waste power frightfully. They provide only two, or, at most, three speeds, differing widely, so that they only divide the one loss into two or three smaller losses, aggregating as much as the one.

Where most experience of electric traction exists, all such gears have been thrown aside, and now they are only brought forward by inventors who may be first-class mechanics, but are certainly totally ignorant of the most elementary facts regarding electric traction.

Mr. Sayers's suggestion that there would be no losses on a Heilmann locomotive, due to starting and slow speeds, if both generator and motor were series machines properly designed, is a mistake. In theory, two machines like that should go round as if rigidly coupled, without loss, but in practice

it does not come out that way, if, as in the case of a locomotive, the motor must start a heavy load. This will be obvious if we consider that the steam engine driving the generator must, and in practice does, make a good many strokes, and discharges a considerable number of cylinderfuls of steam before the motor moves at all. All that steam is absolutely thrown away; and even when the motor does move, the generator is found to be making much greater speed than the motor, the difference in speed measuring the the waste of power going on. If we coupled the steam engine direct to the axle of the locomotive, that axle would require to make a half turn for every cylinderful of steam discharged, and there could not possibly be any difference of speed between the engine and the axle.

The theory of the electromotor is very pretty and exceedingly simple, and works out on paper with the utmost mathematical precision. When we come down to practice, however, it is found that the conditions assumed in the theory are not altogether attainable, and the problem as to how to approximate the best conditions often becomes quite a formidable one; hence when electric traction first began, the engineers, relying upon their mathematics, put on a 5-horse motor to haul a 3-horse car, and provided 5 horse-power per car at the power-house; practice rapidly compelled them to put on 15-horse-power motors, and to provide about 30 horse-power motors per car at the power-house.

Another minor difficulty has cropped up in street railway electric traction—the electrolytic corrosion of gas and water pipes. These have suffered to an alarming extent in some American cities. Various methods of overcoming the difficulty have been proposed, but none are entirely satisfactory. We shall deal with this subject fully at another time.

After all, electric traction on street railways is so convenient, smooth, clean and noiseless, that despite the low efficiency and the other minor difficulties, it has made more progress than any other form of mechanical traction; and we are positively certain that the efficiency will be largely improved, and other troubles removed, by carefully ascertaining the actual facts, and taking rational plans to meet them. It is not by theorising as to how motors should act, and what, according to theory, should be their efficiency in traction work, that anything can be accomplished. It is far safer to take the results of actual practice, and find out how they do act, and what is their actual efficiency. The theoretical efficiency is then valuable as a standard of comparison only.

CORRESPONDENCE.

A Call for more Imagination as a Factor in the Progress of Physical Science, and a few Remarks on Maxwell's Electrical Theory.

I have read with mixed feelings the leading article in your last issue, which advocates a more liberal use of the imagination in scientific research than prevails at present.

My first impression on reading the article was one of sorrow that the Electrical Review should plead for a greater indulgence of the imagination, in these days of unbalanced minds, when we have physicists of the lengthened experience of the chief electrical engineer of the Post Office giving tongue to such wild dreams as telegraphing through a purely hypothetical medium to our planets, and holding out prospects of our being able to hear the noise of thunderstorms, which a lively imagination assumes to exist in that source of terrestrial and planetary energy, Our Sun.

On reflection, it occurs to me that, perhaps after all, the writer of the article only desired to lodge a protest against the journeyman character of the scientific work of some of our physicists, and that the moral he wished to enforce was that all experimental observations should tell a story of some kind. Experimental observations, it must be admitted, are too often recorded much in the same way as boys industriously collect and arrange butterflies, moths, and beetles, without adding to the sum total of human knowledge. Scientific lectures are nowadays largely works of art, many of them being splendid examples of *summa ars est celare artem*; beautiful experiments produced at great cost are exhibited, which appeal to the organ of wonder rather than to the reason, but which at the same time teach the audience little or nothing.

It is often claimed for physical science that it rests upon an *absolutely* sound foundation. If this be admitted, then the converse must be true, viz., that anything put forward which does not rest upon a true foundation cannot be regarded as science.

It seems to me that there exists a good deal of confusion as to the scope and meaning of physical science. Prof. Huxley has defined it as disciplined common sense; I am disposed to think that disciplined knowledge, or disciplined mother wit, would be a better definition, but true science, I consider, would be more correctly described as the elucidation of physical truths. In other words, the elucidation of those laws which control and enter into the structure of matter. Assuming that this latter definition be accepted, then it follows that, in the real sense of the term, that only is science which rests on observations associated with matter, and it follows as a corollary that mental structures, having their origin in conceptions of the brain only, cannot be regarded as revelations of physical truth; and that being so, they should be treated simply as hypotheses.

I fear it must be confessed that we are living in an age of faddism and unbalanced minds, and that the bases on which physicists now rely are day by day becoming more and more unsound. No doubt there are many causes which have tended to bring about this state of things, but I myself consider that the prevalence of agnosticism—among our specialists, more particularly—is the chief factor. Agnosticism may be tersely described as the deification of the human intellect, which it exalts above everything else.

The mathematical physicist reduces everything to a soulless symbol, and he too often attempts, especially if he be a brain worshipper, to deal with the material through the immaterial, and it results that he makes little or no solid advances; his labours ending in more or less ingenious hypothesis, which he energetically defends by casuistic argument.

Now it must be admitted, "take him for all in all," that the mechanical engineer is the most useful all-round man in existence. He has added to our comforts in every way; he has cheapened everything, made the world smaller, and by enabling man to accomplish a greater number of acts in a given time, he has put it in our power to live a fuller existence, and by so doing, he has practically increased the duration of human life.

That the engineer stands out so prominently as a benefactor of humanity, I venture to think arises largely from the fact that he never loses touch with matter. The true engineer reverences matter, which he regards *not* as a soulless symbol, but as a something he can see or feel, and which possesses inertia, the basis of all his operations, the basis of every physical act performed, and the basis also of transmission of solar energy, the food on which all vegetable and animal life so greatly depend for their existence.

Now the engineer is endowed with neither more nor less intellectual capacity than the mathematical physicist, and at times he has to deal with the immaterial; but unlike the mathematician, he approaches it always through the material, and so he accomplishes work sometimes a little in advance of his actual knowledge.

Now, I want to say a few words on Maxwell's electrical theory as an example of what I conceive to be unsound science. Maxwell stood out among his contemporaries as a physicist of the highest intellectual ability, but my contention is, that it passes the wit of man, however able, to mentally propound a true theory.

I myself am very much indebted to that able and industrious physicist Prof. Lodge for what knowledge I possess of Maxwell's theory, but at the time he startled electrical engineers by the revolutionary views he propounded in connection with the experiments exhibited at the Dr. Mann lectures of 1888, I ventured to say I felt sure that what was observed by him would be found to be due to other causes than those which appeared to have satisfied Prof. Lodge, and I would make a similar remark in reference to the highly ingenious and very beautiful, but at the same time complex experiments, of Hertz.

Now, the views propounded by Prof. Lodge in connection with the Dr. Mann lectures, and the papers and discussions these lectures gave rise to, were (1) "he ventured to imply

that none of the older electricians had any notion of the real conditions of the problem;" (2) that "recent advances in electrical theory had made it easy for him to see further than the far greater men of the past," &c.

Among the conclusions which the elucidation of Maxwell's theory have led are, that the central portion of a conductor is stolidly inert to transient electrical currents, which it is declared are confined to an outer skin of microscopical thickness; (2) that "iron conducts rapid electric alternations as well as, or even better than, copper;" (3) that copper conductors are more liable to be fused by lightning than iron ones.

Among the more important experiments exhibited at the Dr. Mann lectures was that described as the experiment of the alternative path. This experiment was, however, misleading, because, as Mr. Wimshurst demonstrated, the spark which leapt the space considered by Prof. Lodge to be an alternative path, was in the opposite direction to what it would have been had the path been an alternative one. Now, although it was a misnomer to call these particular experiments alternative path experiments, they were, in my opinion, very valuable, for they incidentally demonstrated most *conclusively* that Leyden jar discharges pass through the mass of a conductor, as Faraday and the older school of electricians, believed, and that they were not confined to an outer skin of microscopical thickness, as mathematical physicists, on the strength of Maxwell's theory, maintain.*

Now, I do not rely exclusively on Prof. Lodge's Dr. Mann lecture experiments for asserting that Leyden jar discharges are not confined to the outer skin of electrical conductors, fortunately for the position I have taken up all along in respect to the Maxwell theory. Electrical welding experiments, extending over a week, took place at the Institution of Civil Engineers, in which iron bars an inch and a half in diameter were heated by rapid alternations of 30,000 amperes, as estimated by Mr. Crompton, and these experiments went to show that there is no crowding of electrical currents in the outer skin of conductors when transient currents in alternate directions are being transmitted.†

Now, beautiful and ingenious as are the experiments of Hertz, I do not feel much interested in them, because they are complex and consequently difficult to analyse, but if I can demonstrate that a Leyden jar discharge is not oscillatory, then the basis on which the Maxwells rest, it must be confessed, will be destroyed.

Prof. Lodge stated in the course of his very interesting lecture on a Leyden jar discharge, delivered at the Royal Institution, that during the act of discharge the inner and outer coatings of the jar becomes alternately + and −, the current oscillating backwards and forwards through the air path, much in the same way as a marble dropped on a hard stone oscillates.

Now, my contention is that a Leyden jar discharge does not oscillate, and that this can be as easily demonstrated as it is to prove that the earth is a sphere and not a flat plane.

In the course of the last five years, through the medium of the ELECTRICAL REVIEW, I have brought forward a large array of facts in support of the Franklin-Faraday theory and the natural developments of it; but in the journalistic discussion which has occurred between Prof. Lodge and myself, he has invariably raised side issues, and our other physicists whom I have invited on public grounds to refute or confirm what I have brought forward, up to the present time have maintained silence.

Under these circumstances I feel very much like the farmer in *Punch*, who criticised the rare light wines of his aristocratic host, on the ground that he "seemed to get no foradder."

The Marquis of Salisbury, in the course of a public address delivered not so very long ago, stated that if protectionism were reintroduced with a view to ameliorating the condition of the country, he believed that no one could be found who would be willing to invest money on the result being favourable to the general interests of the United Kingdom.

Prof. Lodge and other physicists claim to be able to see further than the electricians of the older school.

I consider it would be to my shame if, with my practical telegraphic and electro-dynamic experience, I could not see electrically a little further than was possible at the time Faraday carried out his researches, and I contend it would in a larger degree be to the shame of college trained endowed physicists of a younger generation than myself if, with the perfectly equipped laboratories they command, and the able assistants they are supplied with, they cannot see further in the matter of the fundamental laws underlying electro-dynamics than I can. Now I want to get "foradder," and with a view to doing so I would like to submit the faith of our mathematical physicist to the Marquis of Salisbury's test, and I would ask them, are they willing to invest money on what they declare to have been demonstrated, viz., that a Leyden jar discharge is oscillatory?

I am not endowed, and my resources are less than that of our endowed physicists, but as an earnest of my faith in the older theory I am willing to invest, say, five guineas, to be given to a charity, if I fail to demonstrate the position I have taken up, and I would ask our physicists, have they, any one of them, sufficient faith in the Maxwell theory to do the same in defence of it?

What I require to demonstrate that a Leyden jar discharge is or is not oscillatory, are two condensers made with sheets of glass, capable of receiving a charge of high potential and the loan of an influence machine. I should prefer that each of the condensers should have not less than 500 square feet of + and − surfaces.

If my challenge be accepted, I will meet my opponents in the matter of supplying the condensers half way, that is to say, I will undertake to give my services gratuitously to superintending the construction of the condensers, so that the actual cost will be but little more than the bare cost of labour and material, and if the results obtained should go to prove the correctness of the Maxwell's theory, I will frankly confess that I have been labouring under error.

S. Alfred Varley.

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* When a Leyden jar or lightning discharge leaps through an air space to a conductor—say a telegraph wire—inertia is encountered and has to be overcome, this involves a temporary absorption and a statical occlusion of energy, accounted for by the atoms of the conductor assuming energy of position in respect to the centre of magnetic gravity of the molecules, the conductor becoming magnetically polar. Immediately after the discharge has taken place, the energy of position of the atoms becomes transformed into kinetic energy in the shape of "extra current," the conductor passing back to its normal unmagnetic condition. The lightning or Leyden jar discharge proper is almost instantaneous, but the "extra current" which follows and travels in the same direction discharges more slowly, its speed being determined by the rate of demagnetisation, and this is influenced by the conditions prevailing. If the conductor be copper, the demagnetisation will be more rapid and the potential of the "extra current" will be higher than if the conductor be an iron one (see paper on the "Mode of Action of Lightning on Telegraph Circuits," by S. Alfred Varley, read before the British Association meeting of 1870, and published in *extenso* in *Engineer* and *Engineering* of the same year). Now, as I have pointed out in articles which have appeared in the ELECTRICAL REVIEW, in my criticisms of the so-called alternative path experiment, the spark which Prof. Lodge assumed to be part of the main discharge passing through an alternative air path was simply "extra current" developed during the act of demagnetisation, and of high enough potential to leap through a small air space.

† The experiments referred to were exhibited in connection with a paper on "Electric Welding," by Sir Frederick Bramwell, read before the Institution of Civil Engineers early in the year 1890.

The Resistance of Selenium.

Having seen in Mr. Werner von Siemens's book, "Personal Memoirs," a statement to the effect that the late Mr. Willoughby Smith was the first person who discovered the variation in the resistance of selenium when exposed to various conditions of light and heat, I beg, in justice to myself, that you will allow me to correct this statement through your valuable paper, and to state that I was experimenting with a case of various electrical bars made of this metal in the testing room of Morden Wharf, Greenwich, in the year 1872, with the view of determining their electrical value and resistance, as we contemplated using them in place of the ordinary "high resistance" in Mr. Smith's system as arranged for shore testing during submergence of cables. These bars were enclosed in a japanned tin box, with a sliding cover, the terminals being at each end outside the case. I suddenly noticed that the same bar gave a very different resistance when tested in the light to what it had done when the cover of the box was closed. I afterwards tested all the bars in the box with a like result. I instantly communicated the discovery to Mr. Joseph May, who was

at that time in charge of our electrical staff at East Greenwich, and *he* communicated the information to Mr. Willoughby Smith. *But to me* belongs the credit of *first* having made the discovery. This matter would appear at first sight not worth mentioning, but for the fact that this very peculiar quality in the metal in question has proved a most important factor in perfecting the *Telectroscope* of Mr. Leon La Pontois, of Pittsburgh, Pa., by means of which it is to be made possible to see the person one is talking to by telephone.

John E. Mayhew,
Late of the T. C. and M. Co's. Electrical Staff.

A Loud Speaking Telephone.

We are somewhat surprised at reading your notice of Graham's Loud Speaking Telephone, on p. 606.

We are sorry to see that you, who usually bring out the very latest, regard Mr. Graham's "invention" as a "novelty."

As soon as the patents had expired in 1892, we brought out a very efficient loud speaking receiver for use with the Hunnings Cone Transmitter, with which it has been working in our offices ever since, and sold in large quantities.

We have not brought it out commercially, as we were informed that it was not necessary that every one in an office should hear all the conversation that was going on. You will therefore see that, although Mr. Graham's instruments may "beggar all description," it is slightly improbable that they will "create a real sensation . . . . and revolutionise our present system of working."

We have made some novel disguises for our Loud Speaker, such as concealing the receiver in a model talking sailor, talking dolls, &c., and other mysteries; and if you can ever call at our offices in Queen Victoria Street, you can hear some very good results in loudness and distinctness of articulation.

The General Electric Company, Limited,
Max Binswanger, *Director.*

P.S.—We consider Mr. Graham's novelty a copy of our "Loud Speaker."

A Complaint.

Will you allow me space on behalf of working electricians generally to ask firms of contracting electrical engineers their reason for instructing their customers to place in charge men who have never seen an electric installation in their lives before, instead of putting men in who have, and thereby reducing the number of young electricians who are out of work, and keep the trade confined more to those who have served both time and money in its progress, instead of letting labourers, fitters, blacksmiths, joiners, &c., have the cream. I have had no less than three installations under my charge that had, before I took them, been run with such men described; the consequence was they were all turned upside down, kept in a filthy condition, and consequently condemned by the owners as "frauds" and "no use," and this is one of the chief reasons, I am sure, that electrical work has not made such progress as it might have done. I think if our leading firms would pay a little attention to this their results would be much better and their trade greatly improved, as people who put down plants would be better satisfied, and extend accordingly, instead of otherwise.

Hoping you will pardon my intrusion, and thanking you in anticipation,

George Kenyon, *Electrician.*
West Hallam Collieries, Ilkeston.

Cost of Electrical Energy.

In the last issue of the Electrical Review, on page 616, among the remarks on Mr. Crompton's paper, I am reported to have said (third line from bottom of my remarks) " . . . . whereby all the seven rollers and their pins were entirely *on wheels*." This gives a wrong impression, and should have been " . . . . were entirely *omitted*." Possibly the fault may have been mine in not speaking sufficiently plain; but all the same, I shall be much obliged for a correction in your next number.

Thanking you in anticipation,

W. Schönheyder.

SOME ATTEMPTS TO RECORD PERIODIC CHANGES.

The investigations of Mercadier, Froehlich, Elihu Thomson, and other physicists, have resulted in the now well-known "telephone" methods of studying alternating currents. In using these methods, great care is necessary in the matter of adjustments, and of distinguishing the natural oscillations of the plate, which are frequently superimposed upon those to be recorded. Many of these are fortunately obviated in an arrangement for studying alternating currents recently suggested by Mr. E. F. Northup, and described by Prof. E. L. Nichols before Section B of the American Association for the Advancement of Science. The following experiments were quoted:—

A mercury stream flowing from the contracted nozzle of a funnel was made to pass between two metal terminals which were attached to the poles of a large Holtz machine. A portion of the falling column of mercury within the electrostatic field was illuminated by means of an arc lamp, and so much of it as could be seen through a horizontal slit was photographed by transmitted light. The sensitive plate was given rapid vertical motion through the field of the camera. When the machine was out of action there resulted a vertical trace running the length of the developed plate. As soon as the machine was put into operation, deflection of the mercury stream occurred. The deflecting forces under these conditions were due to the action between the lines of a stationary magnetic field and those of an alternating current traversing the mercury column.

In another experiment the mercury stream was introduced into the circuit of an alternating current dynamo. It flowed through a strong magnetic field with horizontal lines. The transverse oscillations of the mercury under these conditions were very apparent. When photographed by means of a camera with optical axis, parallel to the lines of force, the stream strongly illuminated from behind, and viewed through a horizontal slit, as in the previous experiment, a sinusoidal trace was obtained.

All the complexities of the telephonic trace disappeared in these records, and curves corresponding to those of the method of instantaneous contact were always produced.

Another attempt to record single periods in dynamo-electric work is described by Moler in the *Transactions* of the American Electrical Engineers, Vol. ix., p. 223. By means of a D'Arsonval galvanometer, with a period of vibration of a few thousandths of a second, curves of varying potential were traced, which showed excellent agreement with measurements by the method of instantaneous contacts. This instrument, however, is not free from the errors due to inertia, and is only reliable in recording changes of period considerably greater than its own; but its use is a step in a direction along which progress may be looked for.

CHELSEA VESTRY AND DUST DESTRUCTORS.

Mr. T. W. E. Higgens, the surveyor to the Chelsea Vestry, has made the following report on "Dust Destructor at Kensal Town, and the advisability of utilising the Heat for Public Baths or Electric Lighting," to the vestry:—

Introduction.—In accordance with the vestry's resolution on March 20th, I have been in communication with several firms as to the erection of a dust destructor at Kensal Town. In my report of that date I said "*in or near*" Kensal Town; but the resolution which was passed on April 3rd, asking the Baths Commissioners to give the use of their land for dusting purposes, seems to me clearly to indicate that the vestry intend a portion of the Baths Commissioners' site to be used for this purpose.

Schemes.—Schemes have been submitted by:—

1. Messrs. Horsfall.
2. The Municipal Appliances Company.
3. Messrs. Manlove, Alliott & Company.
4. Livet's British Steam Generator Company.

Messrs. Horsfall's Scheme.—It is proposed to erect three hand-fired cells, to fix a boiler 12 feet long and 7 feet in diameter, with a chimney 60 feet in height. Two estimates are submitted, the first for iron buildings, and without a roof over the tipping floor, amounts to £1,873; while the second estimate, for substantial brick buildings and roof over furnaces and tipping floor, amounts to £2,273; but in

both these estimates foundations to a depth of only 18 inches below the ground are provided for, and no provision is made for the paving on the tipping floor or in front of the furnaces.

Messrs. Horsfall, whose destructor at Oldham has been examined by the Dust Disposal Committee, intend to use a forced draught, but state that by introducing it at the back of the furnace they will be enabled to put a stop to the noise caused by the steam jet. The opinion that the noise caused by the forced draught might be minimised by proper arrangement of the inlet, was lately expressed by Mr. Crompton in a paper read before the Institution of Electrical Engineers.

The three cells will burn 22½ tons per day, and the makers will guarantee 45 I.H.P. all the time the cells are in full work, reckoning 20 lbs. steam per I.H.P. per hour at 80 lbs. pressure = 90 gallons water evaporated per hour.

If three hand-fired cells are used, one man to each shift of (say) eight hours will be required.

The Municipal Appliances Company's Scheme.—In this scheme four cells are provided with chimney 150 feet high, and two steam generators of about 70 H.P. collective when three furnaces are in use; the furnaces are sunk so that a clinker lift and two silent blowers will also be provided for the furnaces. Brick walls will be built to the sheds, and they will be roofed with galvanised iron roofing. The roadway is to be paved with 4-inch granite cubes, and blue brick paving is to be laid in other places where necessary. Boundary walls on the canal bank and at the east end are also estimated for. The total estimate amounts to £4,086.

Bath Commissioners' Scheme.—This firm, however, have on a former occasion submitted a scheme to the Baths Commissioners, and they state that they are prepared to modify that scheme, and construct four furnaces and three boilers with all necessary works, except boundary walls, for £4,812, but if the furnaces were sunk to a depth of 4 feet, the cost would be £4,895. If in the latter scheme four "Thwaite" boilers giving 30 H.P. each were used, the total cost would be £4,975.

Messrs. Manlove & Alliott's Scheme.—A 2-cell destructor to be built of the kind known as Fryer's improved patent, with chimney 120 feet high. One double fume cremator (Jones's patent) and also forced air blast to be provided, also one multitubular steam boiler 11 feet long and 6 feet in diameter, and auxiliary furnace for coal firing. An elevator will be used for raising the refuse to the top of the destructor, and a 4 H.P. vertical engine will be fixed for working it. The sides and roof of the buildings will be of corrugated iron.

The estimate is £2,937, but this does not include the foundations. If a wrought-iron chimney, lined with fire brick, mounted on brick base, were substituted for the brick chimney, the cost would be £2,437, without foundations.

The British Steam Generator Company's (Livet's) Scheme.—Mr. Cheesewright, their engineer, writes:—"If 84 tons of dustbin or trade refuse be screened, an installation precisely similar to the one at Halifax would be ample for the work you want it to do, and would generate steam sufficient to give 120 I.H.P. for 144 working hours. The approximate cost of the Livet's generator, brickwork, and furnace complete, would be £1,200; this is exclusive of chimney and other buildings.

"A royalty for the use of the patents of, say, 9d. for each and every ton of refuse or rubbish destroyed will be charged, this royalty to be payable quarterly for 12 years, from the date of the installation.

"This arrangement is thought to be the best for the taxpayers, as the charge is borne by the existing ratepayers, although it is advanced in favour of the use of the Livet system, that it must be a source of great profit to any vestry or corporation."

Estimates.—The estimates therefore are:—

1. Horsfall, £2,273.
2. Municipal Appliances Company, £4,086.
2A. „ Baths Scheme, £4,895.
3. Manlove & Alliott, £2,937.
4. Livet, £1,200.

Scheme No. 1.—In this form, however, the estimates cannot be compared, as they are not all for the same work. In No. 1, for instance, the foundations are only taken as 18 inches deep, and no paving is provided for. The paving would cost about £350, extra foundations £100, foundations for chimney £100, making a total of £2,823 for three cells and a chimney 60 feet in height.

Scheme No. 2.—In No. 2 the cost will be £4,086 for four cells, a chimney 150 feet high, and boundary walls; this looks considerably more expensive than No. 1, but when allowance is made for the extra cell, the boundary walls, and the extra height of the chimney, the estimate is not greatly in excess of No. 1.

Scheme No. 2A.—In No. 2A, a scheme suitable for adoption by the vestry in conjunction with the Baths Commissioners; the cost will be £4,895 for four cells (half sunk), and a chimney 150 feet high.

Scheme No. 3.—In No. 3 the cost will be £2,937 for two cells and chimney 120 feet high, but with paving £350, and foundations £100, and chimney foundations, £100, the cost would be £3,487, and if another cell were added at a cost of £500, the total will be £3,987.

Scheme No. 4.—As regards No. 4, the Livet system, I do not think that the scheme proposed can meet with the approval of the vestry. In the first place it is proposed to screen the refuse, and secondly the suggestion is made that the vestry should pay a royalty of 9d. per ton for 12 years. Under certain conditions screening the refuse may be desirable, but the annual payment of a royalty is most undesirable. After all the statements made as to this system, I can only describe their offer as most disappointing.

Cost of Schemes.—It will thus be seen that the costs will be:—

No. 1. £2,823 for 3 cells, 60-feet chimney.
„ 2. £4,086 for 4 cells, 150-feet chimney and boundary walls.
„ 2A. £4,895 for 4 cells, 150-feet chimney, to be adapted to heat baths.
„ 3. £3,987 for 3 cells, 120-feet chimney, and cremators.

Cost, Working and Maintenance.—The cost of working and maintenance is of course an important matter. We would probably require three shifts of eight hours and one man for the yard during the day, which would amount to £6 per week or £312 per year.

The cost of removal of clinkers, &c., allowing a residue of 33 per cent., say, ⅓ on 5,000 tons per year, = 1,666 tons barged away at (say) 2s. 8d. per ton, will be £222 per year.

If the cost of a 4-cell destructor and chimney, 150 feet high, is estimated at £4,000, the interest on the capital at 3½ per cent. would amount to £140 per annum, and if repairs, depreciation, rates and taxes, gas, are estimated at only 10 per cent., they would amount to £400.

Annual Cost.—The annual cost therefore would be:—

Labour	£312
Clinker removal	222
Interest and repayment of capital	281
Repairs, depreciation, rates, &c.	400
	£1,215

Cost of Barging.—The present price of barging away 5,000 tons amounts to £791. It is therefore apparent that to erect a destructor without utilising the heat would mean an extra expense.

Utilisation Schemes.—The question of the purpose to which the heat obtained could be put and the saving caused thereby must now be considered. Two purposes have been suggested, first baths, secondly electric lighting.

Evaporative Power of Refuse.—If 5,000 tons are collected during the year it means about 13¾ tons per day for every one of the 365 days in the year, and every ton will evaporate not less than 40 lbs. of water per hour for 24 hours, thus every ton of refuse will give 2 H.P. for 24 hours. I have no knowledge as to what amount of steam may be required at the Kensal Town Baths (if baths are built), but according to Messrs. Horsfall's guarantee, 1 lb. of water is evaporated, from 60° F. to steam at 80 lbs. pressure per square inch, by 2½ lbs. of refuse, in addition to the steam used for steam jets, boiler feed, pumps, &c.

[Note.—1 lb. of good coal will evaporate 10 lbs. of water.]

Electric Lighting.—As regards utilising the heat for electric lighting, there are many considerations to be borne in mind. In Kensal Town there are slightly over 200 lamps scattered over seven miles of streets. To lay down cables in seven miles of streets for street lighting only (supposing that there was sufficient power in the destructor to light the lamps) would be an exceedingly costly proceeding, and the amount of energy wasted in overcoming the resistance of the conductors alone, would be enormous, especially when it is taken into consideration that the amount of electricity required for the 200 lamps (16 C.P.) at 100 volts would only be about 100 ampères. In fact, to think of lighting the street lamps in the whole of the district from the heat generated in the destructor under present conditions is quite out of the question, apart from the legal objections. It therefore remains to be seen what portion of the district, if any, could be lighted, provided that the heat is not required for the baths.

Provisional Order.—Before the vestry could break up the streets to lay mains for electric lighting, it would be necessary to obtain a provisional order from the Board of Trade, and if an order were applied for, the vestry would be required to supply electricity to private houses within a certain area, and a constant supply within that area would have to be maintained under somewhat stringent provisions. Although the demand for private lighting in this neighbourhood would probably be very small, yet the obligation to provide a constant supply of electricity at a constant pressure, with the limited power which would be available if such a small destructor were the only source of power, is one of such a serious nature that it would not, in my opinion, be wise for the vestry to undertake it.

Power available for Electric Lighting.—If the average horse-power available is only about 26 for 24 hours, there are, of course, many days when less would be available. Suppose that 20 H.P. were only available for 24 hours, and that half the time batteries were being charged. Then we would lose 7 per cent. in the dynamos, and 20 to 25 per cent. in the batteries, or a loss of nearly 5 H.P., without taking into consideration the losses in mains. But as 15 H.P. will only light about 150 C.P. incandescent lamps, it seems hardly worth the trouble and expense of obtaining a provisional order to do this, especially as the destructor buildings and vestry offices would require almost half this number.

Cost of Electricity.—As statements have lately been circulated to the effect that London could be "lit with electric light for nothing," and as the idea is prevalent that any town can be lighted by its dust-bin refuse, it may be as well here to mention that in a paper read before the Society of Arts last February, Prof. Robinson stated that the cost of a unit sold, with repayment of capital and maintenance, amounted in St. Pancras to 5·18d., and that the cost of coal per unit sold amounted to 1·21d., and this price he thought was excessive. The saving by using dust will not be the 3·97d. per unit which is the difference between the cost of coal and the total cost of a unit. For if we take Messrs. Horsfall's guarantee that one ton of refuse will give 1 H.P. for 48 hours, and suppose that we will have no losses of any sort (an ideal state of things) the ton of refuse will give us about 35 units, so that 64 lbs. of refuse will give us one unit, or will be equivalent to 8 lbs. of coal. The cost of coal will be ·760d., while the cost of barging away the 64 lbs. of refuse would be 1·086d., making a total of 1·846d. But this is not all gain, because 21 lbs. of the refuse would have to be removed as clinker, and would cost about ·317d., so that the apparent gain would only be 1·529d. per unit. And if the cost per unit sold is 5·18d., there is a difference of 3·651d. per unit. Thus in this case electricity "for nothing" means at a cost of more than 3½d. per unit, even in such an ideal state of things as I have supposed, where I have taken the cost of coal at per unit *sold*, and the refuse efficiency per unit *generated*, whereas between the two there is

a great gulf in the shape of losses in dynamos, in batteries, and in mains, which would sink any company that were to calculate their price for electricity without taking it into consideration. It is also certain that the cost of working and maintenance of the destructor plant would be in excess of that of the ordinary engines. I am, therefore, of opinion that the cry of "London lit for nothing" is a trifle delusive at the present time, for if the Livet furnace will increase the evaporative power of house refuse, I can see no reason why it should not increase the evaporative power of good coal in like proproportion, and enable electricians to realise their ideal of 2½ lbs. coal per unit generated.

Scheme for Heating Baths.—So far as the schemes now before the vestry are concerned, if it is thought advisable to erect a destructor on sanitary grounds, and to utilise the heat for the baths, and this seems to me to be the best means of utilising it, I would suggest that Scheme No. 2A, that of the Municipal Appliances Company, be adopted, as this scheme has been worked out for the Baths Commissioners, and is therefore, I presume, suitable for their purposes, but no doubt some arrangement would have to be made to provide a supply of very inferior coal to be used when sufficient dust was not available. The scheme would cost £4,895, but as this is more costly than one suitable for the vestry's requirements, the whole cost ought not to fall upon the vestry, unless the extra cost be taken as an equivalent to the site which is handed over.

Scheme without Baths.—If, however, the vestry desire to erect a destructor and utilise the heat for lighting the offices and destructor buildings, and any lamps around the premises which might be lighted without a provisional order, I would suggest scheme No. 1, with the addition of a chimney 120 feet high.

The Question to be Decided.—Before deciding upon the actual scheme, however, the vestry should decide whether the time has yet come when a dust destructor at Kensal Town will be advantageous. The present cost of barging dust will amount to about £800 per annum.

Boilers over Refuse Furnace.—Since writing the above report, I have received from the Municipal Appliances Company a plan showing the application of the "Thwaite" boilers to their refuse furnace. The letter states that each furnace complete with a steam generator would cost £500, provided that at least three were ordered. The special feature in these boilers is that they are fixed on top of the destructor, and no doubt are the very best type to generate heat, though whether they are the best type to destroy foul gases is not so obvious, for at Birmingham boilers form the top of the furnace, but while giving excellent results as to evaporation of water, Prof. Forbes says of them: "It was necessary there to keep up steam for the treatment of the excreta, and steam was got up from these furnaces by putting the boilers directly over the furnace. In consequence of this, the combustion is very imperfect. The large cooling surface of the boilers impedes the combustion in an effectual degree." I cannot, of course, say that the same result will happen with these boilers, but I think that the tendency in some quarters is to sacrifice efficiency in cremation of gases to record breaking in steam production, and this in a destructor, which has been called into existence primarily to cremate, is a mistake.

T. W. E. Higgens, Assoc.M.Inst.C.E.,
Surveyor to the Vestry.

TRANSFORMERS AND THEIR INDUSTRIAL APPLICATIONS.

Société Française de Physique and the Société Internationale des Electriciens.

A special meeting of the Société Française de Physique and the Société Internationale des Electriciens was held May 18th, 1894, at 8.30 p.m., M. de Romilly being president. After reading the report of the last sitting, M. E. Hospitalier remarked that two writers had employed different terms for designating specific resistance. M. E. Guillaume speaks of specific resistances in centimetre-michroms, and M. Pellat in centimetre-michroms per square centimetre. It would be more logical at least to use the same notation in the same report.

M. E. Hospitalier then read a long and interesting paper on "Polymorphic Generators and Transformers of Electrical Energy, and their Industrial Applications." He showed first that electrical energy is produced in the form of continuous, alternating, diphased, and triphased, currents. The continuous form is produced by constant pressure and intensity, the alternating form by an alternating power changing its nature with a frequency varying from 25 to 135 periods per second. These various forms of current may be transformed so as to take each form in succession. The first polymorphic apparatus known were the machines of Clarke and Pixii, which enabled alternating and rectified currents to be obtained by means of a suitable arrangement of brushes. But these machines were not simultaneous. We can now obtain diphased currents from a Gramme ring forming two circuits by uniting opposite points on the ring. M. Hospitalier performs an experiment by means of a machine and a diphased current motor by means of two Siemens bobbins lagging a quarter of a period; then, with the aid of a little demonstration machine by M. Ducretet, giving at the same time both continuous and triphased currents, he supplied an incandescence lamp with continuous currents and a motor with triphased currents. All these properties are turned to account in electrical industry, and machines of 300 kilowatts are now being constructed in America. At Rochester, the Westinghouse Company has established dynamos with continuous currents at 500 volts, and diphased currents at 360 volts, serving both for the distribution in the town and for the tramways. At Paris, also, M. Labour has just undertaken the construction of di-morphic machines. The speaker then showed us drawings (projections) of the Schuckert machines for continuous and diphased currents, the Ducretet machine, the Westinghouse machine, of 300 kilowatts, the Tesla diphased current machine, of 750 kilowatts, the Zipernowsky alternator, formed of two machines mounted on the same axle, and lagging a quarter of a period.

M. Hospitalier then gave explanations on the successive transformations of each of the currents that he had examined. For this purpose he used a large synoptical table.

The transformation of continuous currents into alternating currents is very easily effected by means of rotatory transformers. Certain apparatus have been constructed for transforming continuous currents into alternating currents; amongst others, the Solignac undulator, the apparatus for soldering the rails in America. The transformation of continuous currents into diphased and triphased currents is very easy, with the help of certain apparatus constructed for the purpose; amongst others, those of Schukert, Dolivo-Dobrowolsky, and Hutin and Leblanc.

The transformation of alternating currents into continuous currents has been effected by Messrs. Gaulard, Lane-Fox, and Pollak, and also in the towns of Cassel and Buda-Pesth.

At Cassel, a synchronous alternating current motor fed by the distribution, works two continuous current generators connected on the same axle. These two generators charge accumulators. The principal difficulty lies in starting the alternating current motor. For this purpose the accumulators are used, being discharged into the generators; these latter serve as motors, and act upon the alternating current motor so as to start it. Various solutions of this difficulty in cases where accumulators are not at one's disposal have been adopted, especially by M. Tesla, who uses a small diphased current motor worked by the simple alternating current. The transformation of alternating currents into diphased and triphased currents is effected by turning to account the phenomena of capacity, self-induction and mutual induction. The transformation of diphased currents into continuous currents is also very easily realised by means of the apparatus of Messrs. Schukert, Thomson-Houston, &c. At Buda-Pesth the transmission to a distance is effected by means of diphased currents; they feed a motor which works the continuous current dynamos used to charge the accumulators. There are no special apparatus in existence for transforming diphased currents into alternating currents. Mr. Scott's apparatus enables diphased currents to be transformed into triphased currents. The transformation of triphased currents into continuous currents is effected with the aid of a Gramme ring, by means of Messrs. Hutin and Leblanc's apparatus. There is no special apparatus in existence for transforming triphased currents into alternating currents; but this transformation can easily be effected. Mr. Scott's transformer enables triphased currents to be transformed into diphased currents.

This interesting address, which touched upon the latest problems in electrical science, was delivered before a large audience and achieved a brilliant success.

[1] *Electrical Engineer*, Vol. x., p. 435.

BUSINESS NOTICES, &c.

Automatic Regulator for Dynamos.—We have received from the Indestructible Ignition Tube Syndicate particulars of Conrady's patent automatic dynamo regulator, which is said to work with a promptness and accuracy hardly attainable by the most careful hand regulation. It consists of a suitably wound solenoid, the core of which operates a reversing friction clutch to which power is supplied mechanically. The solenoid thus has no other work to do but to put the friction clutch into or out of gear, and it therefore absorbs only a negligible amount of electricity (from 5 to 30 watts, or as much as one incandescent lamp of from 1½ to 8 candle-power). The power required for operating the regulating means being supplied from a separate source may be made of any required amount without interfering with the prompt and accurate action of the regulator. Thus this regulator may be adapted to operate either a variable resistance, or the brush-holder of a series dynamo, or the throttle valve or expansion gear of the steam or other motor driving the dynamo, or any other means of regulation; and it can be made suitable to control electric supply systems of any kind.

Sunderland and the Electric Light.—Professor Kennedy has presented a report on the proposed electric lighting of the town to the Corporation. From the plans sent him he judges that the suggested arc lighting will replace 80 ordinary street lamps and about 12 100-candle-power Sugg lamps. At 60 yards apart, he makes out that about 50 lamps will be required in Sunderland to light the following streets:—Holmside, Norfolk Street, West Sunniside, Fawcett, Street, Bridge Street, High Street West (to Church Walk), Wearmouth Bridge, and North Bridge Street. He estimates the cost at £40 a year for all-night lamps and £20 for half-night lamps. The total would be £1,500 per annum. On the whole, at the lowest estimate, the cost of arc lighting would be about £550 per annum more than the cost of gas, but the amount of light in the streets would be at least twenty times as great as at present.

A Combined Ammeter and Voltmeter.—The instrument illustrated is a very useful and compact meter. It consists of a strong brass case, 8 inches in diameter, with four terminals; the two small terminals being used for the volts, and the two large terminals for the ampères. It has two hands or pointers, on each pointer is a disc, with the word volts on one, and ampères on the other. By this plan there can be no mistake in the readings, and it will be noticed in the illustration that the disc on one pointer is fixed higher than the disc on the other, this arrangement allows both discs always to be seen, as one disc cannot come in front of the other, and eclipse it. Another feature is a double scale, the top part is used for the volts, reading from left to right, and the bottom part is used for the ampères, reading from right to left. It is not very easy to look at two instruments at the same time, even though they be placed side by side; but in this instrument we see at a glance what is going on, and by mentally multiplying the reading of the one pointer by the reading of the other pointer we get at once the number of watts being used; this makes it also a wattmeter, as each pointer is separate and distinct from the other. It can be used separately as an ammeter or as a voltmeter, as the ampère and the volt circuits are entirely insulated from one another. We also notice that no printed dials are used, each scale is marked by hand during calibration and afterwards engraved; this method prevents any errors caused by the use of printed scales or dials. This is of great importance, which should not be overlooked by users of ammeters and voltmeters, the scale being unusually large, the readings can be easily seen. The principle of the instrument is the action of a solenoid on a suitably suspended piece of iron wire (which weighs only a few grains), and as there are no permanent or electro-magnets, or springs used in them, they never require re-calibrating; the instrument is a gravity one and direct reading, and can always be left in the circuit. To use the instrument it is screwed up vertically so that the hands point to zero, the two small terminals are connected across the mains, and the two large terminals are connected in the circuit, the current and electromotive force will then be indicated at the same time. Let us suppose, for example, the ampère hand points to 28 ampères and the volt hand points to 80 volts, then the one multiplied by the other gives us 2,240 watts; if we again divide this by 746 this gives us $3\frac{1}{3}\frac{7}{7}\frac{3}{3}$, which is the electrical horse-power. The patentee of this instrument is Mr. W. R. Morris, 34, Livery Street, Birmingham.

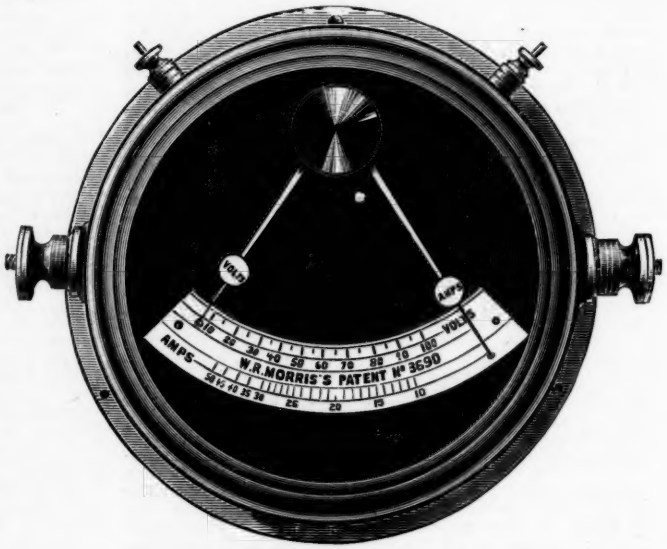
Dock Electric Lighting.—The Works Committee of the Clyde Trust have had under consideration for some time the question of the lighting of and providing crane accommodation for the new Cessnock Dock. On December 26th last a report was submitted to the committee containing information collected on visits to English and Continental ports regarding electrical and hydraulic appliances. In view of the recommendation in that report that tenders be taken for an electric light installation to light the dock and work nine cranes on the south quay of the north basin, the sub-committee were directed to take tenders for nine 35-cwt. hydraulic cranes, and installation for working the same, and alternatively tenders for nine 35-cwt. electric cranes and installation. The committee accordingly procured twelve tenders for hydraulic power installation, and twenty for electric power installation, but none of the tenderers, though requested, furnished any data as to the cost of working and maintenance. An examination of the tenders showed that the first cost of the electric installation would be much greater than hydraulics; and this fact led the committee to recommend the adoption of a hydraulic installation for this part of the dock. The committee further recommend the acceptance of the tender of Messrs. Fullerton, Bodgart & Barclay, Limited, Paisley, for the supply of the installation, including an auxiliary engine and nine non-derricking 35-cwt. cranes placed on gantry carriages, the contract to be completed in six months. The Committee of Management, which includes all the members of the Trust, have approved of the recommendation; and consideration of the mode of equipping the remainder of the dock has been remitted to the Committee of Works.

Electric Light at Accrington.—Messrs. Howard and Bulloch, Limited, of Accrington, have had working for a considerable time an unusually large electric plant for lighting and driving the recent extension of their works. There are two dynamos which are driven with two straps, one off the fly-wheel, and the other off the pulley on the crankshaft with straps. The two dynamos are shunt wound, running at 700 revolutions per minute, 110 volts, capable of 550 ampères each, but they are only at present working at 550 for both, as they are not fully loaded yet. Cables run from these dynamos to 11 motors in different parts of the works. The one furthest away is 200 feet from the dynamo, and these motors run at 500 revolutions per minute, and 110 volts, capable of from 60 to 70 ampères each.

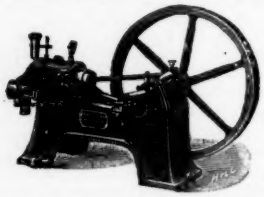
Country House Lighting.—Lady Howard de Walden's country house in Worcestershire is being fitted up for the electric light by Messrs. Allpress. A gas engine will be used to charge a large battery of cells, and the wiring and fittings will be for about 400 lights.

Electric Light at Worcester.—Mr. Milner Allen, one of the architects of the new premises, has been requested to report upon the question of lighting the Victoria Institute by electricity.

Mill Lighting.—Messrs. Bennett & Druce have received instructions from Messrs. Ormrod Hardcastle & Co., Limited, Bolton, for the complete lighting of their mills. The plant will consist of a 78-kilowatt dynamo driven off the main engine, and about 1,250 lamps of 16 C.P. A plant, consisting of a "Marshall" vertical engine and a 100-light dynamo, will also be installed to supply the lamps required during the daytime. The design and arrangement of plant has been carried out by Messrs. Shepherd & Watney, consulting engineers, Leeds.



Monarch Gas Engine.—Messrs. W. H. Baughan & Co., of Charlbury, are putting on the market a gas engine to which they have given the name of the "Monarch." It has Otto cycle and tube ignition, is said to be easily started and to work quietly, and is fitted with a sensitive governor which controls the speed under extreme



variation of load. All the parts are easily accessible, and the consumption of gas is said to be comparatively small, a three horse (brake) power engine costing 2d. per hour at full load, with gas at 3s. per thousand.

Dover Electrical Exhibition.—The Electrical Exhibition under the auspices of the Dover Electricity Supply Company, Limited, which took place at the Town Hall, Dover, on Friday and Saturday last, was very largely attended from the district. Among the chief exhibits, besides the light, were electric cooking utensils, electro-plating, the phonograph and telephone, an electric tram, and various other electrical appliances. The centre of attraction each evening was the telephone, which, by special arrangement with the National Telephone Company, was connected up with some of the London theatres and music halls.

Electric Light at Liverpool.—Messrs. W. Liley & Co., of Liverpool, have lately carried out the electric lighting of the following offices and business premises in Liverpool:—The Guardian Fire Offices, Dale Street; Messrs. Stone, Fletcher, Hull & Stone, Castle Street; Bradley & Son, Dale Street; Greenshields, Cowie & Co., Castle Street; Dunthorne & Co., Harrington Street; Mr. P. Debert, Church Street; Mr. Clay, Castle Street. All these premises are connected to the Liverpool Electric Supply Company's mains.

Moss Side (Manchester) Electric Lighting.—A conference between the Moss Side local authority and the directors of the Collier-Marr Company, Limited, Manchester, has resulted in the withdrawal of all opposition by the local authority, and the Board of Trade have granted the provisional order for electric lighting of the Moss Side district to the Collier-Marr Company, Limited. The work will at once be proceeded with.

Mansion Lighting.—Messrs. Veale & Co., Limited, of St. Austell, have just completed an electric light installation for Mr. Robert Harvey, of Dundridge, near Totnes. The mansion is very extensive, and altogether 135 lamps, varying from 8 candle-power to 32 candle-power each, have been put in. The electric current is generated by means of a Crompton dynamo, driven by a 7 H.P. oil engine.

Electric Light in Newspaper Offices.—Messrs. John Bolding & Sons, Limited, have been instructed to carry out the complete wiring of the *Scotsman* office, Fleet Street.

Exeter Electric Lighting.—At a meeting of the Devon Standing Joint Committee last week, an offer of the electric light company to carry out an installation at the central station for £55 was accepted, the estimated annual cost of maintenance being set down at £39, as compared with £30 18s., the present gas charges.

Worcester Electric Lighting.—The Watch Committee have decided to charge private consumers 5d. per unit, subject to discounts of 5 per cent. for cash, 3 per cent. on bills of from £25 to £50, 5 per cent. from £50 to £100, and 10 per cent. from £100 upwards.

Nalder Brothers & Co.—We understand that this firm is now making Major Cardew's new recording leakage indicator for high tension alternating circuits, as communicated by him to the Royal Society some days ago.

Change of Address.—Owing to extension of business, Messrs. Bennett & Druce are removing to larger and more convenient offices at 30, Winckley Square, Preston, on June 1st.

CONTRACTS OPEN AND CLOSED.

OPEN.

Acton.—The Local Board are inviting tenders for the transfer of their provisional order, and for the installation of electric lamps in the streets. Further particulars may be obtained from the Surveyor, Mr. D. J. Ebbetts.

Alford.—June 9th. The inspectors for lighting the town of Alford are prepared, on and after the 26th day of May instant, to enter into a contract for lighting the town with gas or other light, from August 14th, 1894, to May 14th, 1895. Tenders will be received at the office of the Inspectors, West Street, where all particulars may be obtained.

Bedford.—June 16th. For the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough, for the Corporation. The contract will be split up into two sections: (1) construction, supply, and erection of boilers, steam engines, gas engine, economiser, feed-pumps, condenser, alternators, and switchboard; (2) supply and laying down of transformers and mains. Specifications may be obtained from and plans may be inspected at the office of Mr. F. H. Medhurst, B.Sc., M.I.E.E., 13, Victoria Street, Westminster, S.W.

Coventry.—June 13th. For erection of an electric lighting station at Coventry, for the Coventry City Council. Plans and specification and bills of quantities on payment of the sum of £2 2s. (which will be returned on receipt of a *bonâ fide* tender), on application to Messrs. George and Isaac Steane, architects to the Council, 22, Little Park Street, Coventry.

York.—June 5th. The directors of the North Eastern Railway Company are prepared to receive tenders for the undermentioned articles in such quantities as they may require, during the six months ending December 31st, 1894, delivered carriage paid at the Company's Telegraph Stores at York:—(1) Telegraph apparatus, (2) telegraph wire and line stores.

CLOSED.

Portsea.—The guardians received seven tenders for providing and fixing the electric light fittings in their offices. A local firm, Messrs. Walker & Co., quoted the lowest price (£67), and their tender has been accepted. Two other local firms sent in estimates as follows:—Mr. S. Grossmith, £79 17s. 6d.; Mr. J. R. Penning, £119.

NOTES.

Variable Speed Gearing for Electric Traction.—With the object of attaining the most economical working, we understand that the Gas Traction Company, which represents the most powerful rival to electrical traction, has secured an exclusive licence to use the Beaumont variable speed gear for traction purposes on tramways and light railways. With this gear it is claimed that not more than half the motor power now required on electrical cars would be wanted, and that there would be a corresponding saving in the generating station.

Smoke Nuisance.—The City of London Electric Lighting Company were last week summoned by Inspector Grist, acting on behalf of the St. Saviour's District Board of Works, for allowing black smoke to be sent forth from their premises in Bankside in such quantities as to be a nuisance, and contrary to the provisions of the Public Health Act. Counsel representing the company asked for an adjournment on the ground that the summons was not served till the 21st May. Mr. Kennedy adjourned the summons for 14 days.

Library Electric Lighting.—The Norfolk and Norwich Library shareholders last week decided to have the electric light fitted up in the Library in place of gas.

The Royal Society.—The following papers were down for reading yesterday afternoon:—"Propagation of Magnetisation of Iron as affected by the Electric Currents in the Iron," by Dr. J. Hopkinson, F.R.S., and E. Wilson. "On the Electrification of Air," by Lord Kelvin, P.R.S., and Magnus Maclean. "Note on the Possibility of Obtaining a Unidirectional Current to Earth from the Mains of an Alternating Current System," by P. Cardew. "On the Effect of Magnetisation upon the Dimensions of Iron Rings in Directions Perpendicular to the Magnetisation, and upon the Volume of the Rings," by S. Bidwell, F.R.S. "The Effect of Mechanical Stress and of Magnetisation on the Physical Properties of Alloys of Iron and Nickel, and of Manganese Steel," by H. Tomlinson, F.R.S.

The New Pacific Cable.—Sir Albert Rollit gave his opinion regarding the proposed new cable at the London Chamber of Commerce meeting last week. He considered that "the Inter-Colonial Congress at Ottawa, and the advocacy of Canada and Australia of British cable and other inter-communications, called for every sympathy, and even, if necessary, for some economic sacrifices. And, indeed, there was a more selfish reason for action in this direction, for if, in any hostilities in India, the overhead wires between Bombay and Madras were cut, the only available line of electrical communication with Madras or Calcutta would be through Russia and Eastern Asia, which might scarcely be satisfactory."

In the House of Commons on Monday it was stated that Lord Jersey has consented to represent the British Government at the Ottawa Conference this month.

Boiler Testing.—Referring to our article of May 18th, on "the Cost of Electrical Energy," a volatile contemporary, jaundice hue, falls foul of the tests to which we referred, and says that according to Prof. Kennedy they are worthless. If our contemporary had read the article more carefully, it would have perceived that we referred to these tests as being of short duration, from outside circumstances, and they were not advanced as professorial tests. As a fact, they were made for commercial purposes by the chief engineer of one of the largest fuel consumers in the South of England, and we used the figures so kindly placed at our disposal because they showed how, with a wide difference in the mode of working, two sets of boilers gave so nearly similar results. The worth of a test is entirely dependent upon the purpose for which it is required. The tests we quoted were good enough to form a basis for very large coal contracts, and were made by an engineer whose record as a coal economist in a large practical way stands very high, as, indeed, it should do, seeing that for over 30 years he has been intimately connected with steam using and making. He is not a professor making refined tests for competitive purposes, but for his own information, to reduce cost of evaporation per 1,000 gallons.

Society of Engineers.—At the meeting of this Society, to be held at the Town Hall, Westminster, on Monday next, June 4th, a paper will be read on "Power Distribution by Electricity, Water and Gas," by Mr. Ed. C. de Segundo, of which the following is a synopsis:—Definitions of "efficiency"—Efficiency of steam engine and boiler—Efficiency of gas engine and generator—Thermal value of town gas—Carnot's function cannot be applied easily to gas engine performance—Maximum probable temperature attained in gas engine cylinder—Chief faults in gas engines of present day—Efficiency of individual portions of plant in electric central generating stations—Efficiency of whole plant in practice—Similar considerations relative to hydraulic power stations—Steam engine not so wasteful a heat machine as usually considered—Initial form of energy available, and final form required as factors in economy of distributing systems—Hydro-electric scheme—Comparison with purely electric distribution—Scheme for gas engine electric sub-stations for electric lighting of towns—Efficiency of gas burner—Efficiency of electric burner—Others reasons in favour of this scheme—Example of utilisation of existing hydraulic power supply for private electric light installations—Conclusion.

Plymouth and Electric Lighting.—The Water Engineer has been instructed by the Corporation to report how far the waste of water in the district could be utilised for the generation of electricity.

Asylum Electric Lighting.—It is proposed to erect a new lunatic asylum at Winwick, near Warrington. There was an enormous disparity between the tenders for the electric lighting of the asylum, the highest being £6,000, whilst the lowest was £1,750.

Electric Light at Belfast.—A few weeks ago the Board of Guardians, considering their gas bill too heavy, made inquiries as to the cost of electric lighting. After investigating the matter, they have now discovered that gas is the cheaper by £96 per year, and have therefore decided not to adopt the electric light at present.

Obituary.—The death occurred some days ago of Dr. Karl Eduard Zetsche. In the year 1880 he became editor of *Electrotechnische Zeitschrift*. After a few years he went to Dresden, where he has since devoted his attention to literary and scientific occupations. He was the writer of several books on geometry, trigonometry, and telegraphy. Dr. Zetsche was a foreign member of the Institution of Electrical Engineers, and was also on the rolls of several Continental and other scientific societies.

Electric Phenomena during Thunderstorms.—The following very interesting letter appeared in the *Standard* of yesterday from the pen of C. S. Du Riche Preller, residing at Baden, Switzerland:—"Some exciting and horribly beautiful, but also very dangerous, electric phenomena were observed in the picturesque Canton of St. Gall, on the evening of the 25th inst., during a thunderstorm of extraordinary violence, accompanied by a deluge of rain. The large 'village' of Gossau, about seven miles from the town of St. Gall, derives its electric supply for lighting and motive power for industrial purposes from a hydro-electrical central station, situated at a distance of eight miles, by a high tension transmission, with transformer stations in the village. The thunderstorm, accompanied by violent lightning discharges, passed over the place at 5 p.m., and then, driven back by a change of wind, returned, and lasted for several hours. Soon after 5 p.m. all the electric lights went out spontaneously, but the place was illuminated by violent sparks and flashes, which were emitted by the overhead wire system, and ran along the conductors. These phenomena reached their height at the principal transformer station, close to an hotel; for here the high pressure current escaped from the conductors to earth—viz., the ground saturated with rain—the effect being a succession of flashes or continuous blaze, which so endangered the building that the fire brigade had to be called out to protect it. These phenomena continued for several hours, till the electric supply was cut off at the central station, a special messenger on horseback having been despatched thither, for, wonderful to relate, the installation was as yet without telephonic communication. The lightning struck several houses in the village, though without doing harm; but a young man of powerful build, and of local position and great promise—for he was to have been elected Mayor on the very next day—inadvertently touched one of the electric cables, and was instantly killed. The inhabitants of the place might have been spared the terror of these phenomena, and probably no human life would have been lost, if the electric supply had been cut off during the altogether exceptional thunderstorm, as should always be done—and in the United States is done on some electric tramways—in districts visited by violent atmospheric discharges, and where overhead wires are used. Only last summer I witnessed a similar occurrence on the Mont Salève electric railway, near Geneva, where the lightning struck the feed-conductor of the line, and thence found its way along the transmission cables to the central station, fully two miles distant, where it passed through the lightning arrester and burnt out one of the huge 1,000 horse-power dynamos. In this case, too, the lightning discharge was only the indirect cause, the direct cause being that the dynamo was running at the time, viz., that the current followed the discharge through the not quite perfect lightning arrester, and 'short-circuited' the dynamo."

Personal.—We are pleased to hear that Mr. Arthur Ellis, late resident electrical engineer at Cambridge central station, has been appointed engineer to the Southport Corporation.

Brechin and Electric Lighting.—By six votes to five, the Police Commission have decided to apply for a provisional order to introduce electric light into the town.

Electric Lamps for the Royal Navy.—Experiments with the multiple filament electric lamp having been completed and reported on favourably, the Lords of the Admiralty have directed that it is to be adopted for a masthead flashing lantern in all ships, from second-class cruisers upwards. The work of fitting the ships is to be taken in hand at once, so that they may be supplied with the lanterns when they commission for the manœuvres.

Photographing by Electric Light.—Experiments were made last Friday and Saturday night to test an instantaneous system of photographing by electric light, by the military authorities at Plymouth. Captain J. E. Meryon, of the *Defiance*, was at Cremyll, and the military authorities at Mount Wise. An electric cable was carried across the harbour and connected up to H.M.S. *Devastation*, flagship, who worked her dynamo.

Ajax Defying the ——— Popular Review of Electricity.—Choice and fitting language enhances the value of any subject just as a decent suit of clothes improves the appearance of some men. But language and clothes can be carried a little too far. Language should be the setting, the subject the precious stone. Too often one comes across language which is beautiful setting, but worthless from the absence of the precious stone, and one frequently meets suits of clothes which strut about and make a brave show, but there is ne'er a man inside. We have been twitted occasionally with not dressing up our subjects in fine habiliments, but it is so easy to criticise, and fall at the same time into a pit. On the score of grammar, for instance, we notice our critic is so slipshod, that in its last issue it says: "The Corporation . . . . have invited Mr. Hammond to confer with them on *Tuesday evening last*." But what is slipshod grammar compared with the stupid blunder made by our contemporary in its so-called "Review of Reviews." Not content with attacking us in our own private paragraph, the writer is so full of bitterness that when making an onslaught on another poor contemporary, he cannot forget us, and uses our copyright title instead of that of the other offender.

Combination Incandescence Lamps.—The demand for incandescence lamps which can be made at will to give different illuminating powers, or which can be "turned up or down," as in the case of gas lamps, has not been very pronounced, but, nevertheless, there are numerous cases in which such lamps would be useful, and in which they would be adopted if placed upon the market. For sick rooms, hospitals, &c., a lamp burning at a low incandescence would be a great boon, and would be far preferable to a small lamp burning at full power, even though the actual candle-power given by the latter were but small. Combination lamps in which more than one filament is employed are of course not novelties, but we believe that no serious attempt has hitherto been made to combine these filaments with a switch, so that by turning the latter various candle-powers can be produced. Messrs. Burbey, Williamson & Joseph, have recently introduced an arrangement of a double filament incandescence lamp in which, by means of a special switch in the holder, these filaments can be used singly, coupled up in series, or in parallel, so that four different degrees of light can be obtained, from a low incandescence to the full brilliancy of the two filaments. So far as we have been able to judge, the arrangement is simple and effective, and although probably not very efficient at the low candle-power, is sufficiently so to justify its use, seeing that the proportion of lamps which in any establishment would be run for any length of time at such low power would not be considerable, whilst the convenience of obtaining the variation in a simple and inexpensive manner would be undoubted.

Hanley Electric Lighting.—Trial was made on Monday last week of the electric lighting of the streets of Hanley, and the experiment appears to have been successful.

Church Lighting.—The Parish Church of Itton, was last Sunday lighted by electricity for the first time.

Balloon Society.—At the weekly meeting of this Society, held at the Gallery, 9, Conduit Street, on the 29th ult., Mr. Charlton Wollaston, C.E., delivered an address on "Telegraphy—Present, Past and Future."

Weston-super-Mare Electric Lighting.—The Town Council have resolved, by seven votes to six, "that the Electric Lighting Committee be instructed to choose an engineer to report on the whole question of the electric lighting, electric trams, and destructors, at a fee of fifty guineas, not including personal out-of-pocket expenses."

Newcastle and the Electric Light.—A meeting of the Special Corporation Committee appointed to consider the provision of the electric light for Newcastle was held last Wednesday, when it was resolved to report to the council that it was desirable that the Corporation should be in a position to supply the electric light in the city, and it was further decided that, as a step in this direction, investigation be made into the merits of the supply of the light by municipal authorities.

NEW COMPANY REGISTERED.

Elieson Electrical Switch, Limited (41,226).—This company was registered on the 25th ult. with a capital of £5,000 in £1 shares, to enter into an agreement for the acquisition of the patent rights in Great Britain, Ireland, and the Colonies, of certain inventions by Mr. C. P. Elieson; and to carry on the business of electricians. The subscribers (with one share each) are:—Earl of Galloway, 17, Upper Grosvenor Street, W., Peer and Knight of the Thistle; P. Polenghi, Larchwood, Horley, merchant; C. P. Elieson, 75, Edith Road, West Kensington, electrical engineer; M. Fredemon, 8, Regent Street, S.W., merchant; M. Watson-Thomas, Princes House, Palace Street, S.W., solicitor; E. Pellas, 8, Regent Street, S.W., merchant; L. T. Long, 17, Porchester Square, W., solicitor. The first directors are The Earl of Galloway (chairman), Paolo Polenghi, and C. P. Elieson; remuneration, £2 2s. each for every board attendance. Many of the rules of Table A apply. Registered by Watson-Thomas & Co., College Hill Chambers, E.C.

CITY NOTES.

The Gülcher (New) Electric Light and Power Company.

THE lamentable history of this company is almost drawing to a close, for we learn from the latest report and balance-sheet (which is up to June 30th, 1893) that "the directors have for some time past taken steps to limit the engagements of the company, in view of its possible voluntary liquidation, a course which they will recommend the shareholders to adopt at the ensuing general meeting."

It is a meagre and mournful document; but the period which it covers is so remote, that worse may remain behind. Besides a knowledge of the present condition of the company, it would be particularly interesting at this stage to know the financial results of the general contract for the Genoa station.

The misfortunes that have attended this ill-starred company will be attributed to various causes; but we are reluctantly compelled to say that, in our judgment, the chairman has been in a great measure to blame for the series of disasters. Mr. de Castro may be an able man in his own walk of life, but he was wholly unfit for the duties of a working chairman of an electrical manufacturing company. If he had exercised the usual functions of a chairman, and left the business to other hands, there was a remote possibility of successful trading, for the Gülcher Company has had at times the assistance of able men; but the chairman left neither well nor ill alone, and to his extraordinary policy, based on mere sanguine expectations, we consider the position of the company is due. We do not for a moment suggest that Mr. de Castro acted from any but the best of motives, but good intentions badly executed simply mean disaster in an industrial company. It must also be pointed out that Mr. de Castro lost no opportunity of alienating the sympathy of the shareholders of the company. There was not the openness about the proceedings of the company that one would have liked; above all things Mr. de Castro had a mortal terror of newspaper reporters, and never with his good will were they present at the meetings of the company.

We append the report and balance-sheet, and how depressing it is we leave our readers to judge.

"The accounts from our New Zealand branch, which reached England in November, were insufficient, and had to be returned to New Zealand for completion and correction, involving a delay of nearly five months. Hence the impossibility of calling the present general meeting earlier.

"Notwithstanding the large order from the New Zealand Electrical Syndicate, Limited, and the hopes thereby raised, the result of the year's working has been a serious loss. The sales in England dwindled down to less than £5,000, and the hire of installations practically ceased.

"Under the circumstances the directors have for some time past taken steps to limit the engagements of the company in view of its possible voluntary liquidation, a course which they will recommend the shareholders to adopt at the ensuing general meeting."

BALANCE SHEET to June 30th, 1893.

DR.	£ s. d.	£ s. d.
To Capital authorised—		
70,000 shares at £1	70,000 0 0	
Issued 20,000 deferred shares	20,000 0 0	
12,277 10 per cent. preferred shares fully paid ...	12,277 0 0	
37,723 10 per cent. preferred shares at £1, called up 15s.	28,292 5 0	
70,000 shares.	40,569 5 0	
Less calls unpaid ...	600 0 0	
	39,969 5 0	
Add calls paid in advance	3,838 5 0	
		43,807 10 0
To £6 per cent. mortgage debentures	—	8,000 0 0
„ Second mortgage debentures, bearing 10 per cent. interest	—	500 0 0
„ Accrued interest on debentures ...	—	185 0 0
„ Sundry creditors—		
On bills payable	3,308 17 5	
On loan account	2,370 3 4	
On open account	4,114 15 6	
		9,793 16 3
„ Liability of £4 10s. calls upon 200 shares in the New Zealand Electrical Syndicate, Limited ...	900 0 0	
		£62,286 6 3

CR.	£ s. d.	£ s. d.
By Cash in hand and at bankers		69 18 4
„ 2,000 shares at £10 each fully paid in the New Zealand Electrical Syndicate, Limited		20,000 0 0
„ 200 shares at £10 each, paid up to £5 10s., in the New Zealand Electrical Syndicate, Limited ...		1,100 0 0
„ New Zealand branch—	£ s. d.	
Stock, cash and book debts ...	4,276 3 3	
Goods in transitu	841 9 5	
	5,117 12 8	
Less liabilities	1,085 5 11	
		4,032 6 9
„ Consignment to New Zealand		15 6 7
„ Sundry debtors		1,740 5 6
„ Genoa stores		125 15 2
„ Plant	6,732 4 8	
Less written off	2,232 4 8	
		4,500 0 0
„ Stock in England	12,509 17 5	
Less written off (per valuation of your manager)	4,509 17 5	
		8,000 0 0
„ Profit and loss balance, June 30th, 1892	6,880 1 8	
„ Profit and loss balance, net loss, June 30th, 1893	15,822 12 3	
		22,702 13 11
		£62,286 6 3

County of London and Brush Provincial Company, Limited.

We have pleasure in publishing the following letter:—"In the last week's issue of the Electrical Review there was a paragraph stating that the annual returns of this company had been filed at Somerset House on April 9th. Although the information given in that paragraph was absolutely correct so far as it went, it has created the impression among some of your readers that the return referred to the company's present position, instead of to that of last year. Would you mind inserting a note in this week's issue that the 19,000 shares of £10 each, offered for subscription on April 5th, were taken up and allotted on the 10th of that month, and that the whole of the 20,000 shares forming the first issue have now been subscribed for, and £40,600 paid. "Yours truly,

"The County of London and Brush Provincial Electric Lighting Company, Limited,

"H. Broadhurst, *Secretary*."

West Coast of America Telegraph Company.

The seventh ordinary meeting of this company was held on Tuesday at Winchester House, Old Broad Street, under the presidency of Mr. J. Denison Pender.

The Chairman, in moving the adoption of the report, paid a tribute to the memory of the late Mr. Roberts, one of the directors, who had died since the last meeting, and referring to the accounts, he said that the gross receipts were £7,122 less than in the previous year, but in 1892 the receipts included £4,728 received from the Chilian Government as compensation for the time they were closed up during the war. In that year, too, the rates of exchange in Peru and Chili were more favourable than they had been since. The actual total of traffic showed 131,700 words in excess of those carried in 1892. If the exchange had ruled the same, they would have had a considerable increase in the revenue. The general expenses in London were much the same, as were also the expenses of stations. The working expenses of the repairing steamer, *Retriever*, showed a reduction of £1,021, but it must always be remembered that that item varied according to the work which the steamer had to do. The revenue charges showed a reduction of nearly £1,000. The decline in the rate of exchange was the most serious thing with which they had to contend, as they must keep their staff up, and in face of competition they could not raise their rates. The traffic over the Talcahuano line had been very satisfactory, and no doubt their income would be materially increased thereby. As to the opening of the line between Buenos Ayres and Valparaiso in March last, he said that at the last meeting he said it would be opened in three months, but several causes for delay, over which they had no control, had occurred. The share capital was held by the companies chiefly interested in the traffic going over the line, and the principal and interest of the debenture capital was guaranteed by this company and the Brazilian Telegraph Company. The traffic over the line appeared to be very satisfactory, and the actual time taken for a message from the West Coast to London was not over an hour. He could not give any information as to the revenue from that line, as it had only been opened two months. He was, however, glad to be able to say that he was pleased with the revenue they were getting.

Mr. Walters seconded the motion, which was adopted, and the retiring directors and auditors having been re-elected, the meeting closed with a vote of thanks to the directors.

The Consolidated Telephone Construction and Maintenance Company, Limited.

The directors' report for the year ending March 31st, 1894, states that in the present accounts due effect has been given to the special resolution of the shareholders, passed and confirmed in March, 1893, reducing the capital:—£17,485 has been written off goodwill, patents, &c., and £5,000 from the shares in the Edison Gower-Bell Telephone Company. The preference shares issued to that date have been expunged by their repayment in full; 2s. per ordinary share has been returned to the shareholders in cash, and 2s. per ordinary share has been written off in accordance with that resolution. The operations for the past year show a manufacturing profit of £3,070 10s., and a net profit of £2,577 15s. 5d. With the amount carried forward from the year 1892-93, viz., £1,117 18s. 6d., a balance of £3,695 13s. 11d. is left for disposal, after making provision for doubtful debts. The directors propose to deal with this amount as follows:—(1) To pay a dividend of £2 per cent. for the year; (2) to write off a further £63 16s. 8d. from the cost of the new building, 10 per cent. from furniture account, and £15 from goodwill, patent rights, &c.; (3) to reserve £122 7s. 11d. for rentals paid in advance; thus leaving a balance of £1,301 4s. 6d. to carry forward. It will be noticed that no depreciation of plant and machinery is made in the present accounts. An independent valuation was made on March 21st, 1894, by an expert, and his report (which is open to inspection) places the value at an amount considerably in excess of that shown in the balance-sheet. The directors cannot but think that the shareholders will consider this a valuable testimony to the care taken of their property. It will further be noticed that this year's accounts exhaust the original expenses incurred in the formation of the agencies. Business in the latter part of the year became more brisk and profitable; the agencies have been fairly busy, and whilst the directors see with regret that some large users of the telephone in this country are placing their orders with agents of foreign manufacturers, they trust that ultimately the superior workmanship of the company's productions will, with fair prices, obtain still more favourable consideration. Every economy that can, with prudence, be practised, is having attention. Friendly relations exist with the various Government and Colonial departments, and the directors are using every legitimate endeavour to maintain and increase such. The directors have again unanimously agreed to relinquish one-half of their fees for the year. The subsidiary company, the Anglo-Portuguese Telephone Company, makes progress with its number of subscribers and rentals value. The following table shows the comparison with last year:—

Year ending March 31st, 1894.

Subscribers.		Rental.		Increase.	
1893.	1894.	1893.	1894.	Subscribers.	Renta
2,249	2,320	£14,487	£15,076	71	£589

In accordance with the articles of association, the following directors retire by rotation, and, being eligible, offer themselves for re-election, viz.:—Sir Alex. Armstrong, K.C.B., &c., and A. H. Baker, Esq. The auditor, J. G. Griffiths, Esq., F.C.A, (Messrs. Deloitte, Dever, Griffiths and Co.), also retires, and offers himself for re-election.

In the presence of a small number of shareholders, the annual report of the company was presented yesterday at Winchester House.

Mr. Fitzgerald, the chairman of the company, said it would be within their recollection that in the early part of last year they passed special resolutions for the reduction of capital, and the balance-sheet showed that it had been reduced in the following manner:—They had paid back to the preference shareholders the sum of £27,637, and to the ordinary shareholders they had paid 2s. a share, which amounted to the sum of £22,485, and in addition to that they wrote off the ordinary share capital the sum of £22,485, £17,485 of this being written off the goodwill, patent rights, &c., and £5,000 from the securities and balance-sheet of the Edison-Gower-Bell Telephone Company. It meant that the capital now stood at 224,850 shares of 10s. each fully paid. He thought the shareholders ought to be very much gratified with the fact that on an independent valuation of the plant and machinery it was found that, instead of representing £5,300, the sum at which it stood, it was worth no less than £7,000. This was so satisfactory that the directors considered it almost worthless to write off anything this year. The stock of instruments last year amounted to the sum of £8,200, this year they amounted to the sum of £7,424. That in itself was a satisfactory item, for on account of deterioration the less stock in hand the better. The debts last year were £8,813, this year they stood at £7,481; of that sum the subsidiary companies owed to them £5,197. The subsidiary companies were the Anglo-Portuguese Telephone Company, or rather, he should say, that the Edison-Gower-Bell had sold their business to the Anglo-Portuguese Company, consequently the question became one of what was the position of the Anglo-Portuguese Company. He thought the position was very satisfactory. Exchange had seriously affected this company, for it lost no less than £2,000; that sum would represent double the dividend they received on the Edison-Gower-Bell Telephone Company. All they could do with reference to exchange was to hope for an improved rate. There was a small amount of £77 10s., the balance of £155 which they had received from the Austrian Telephone Company. He wished to say with reference to the securities they held, that the amount of these were put, not at the market value of the shares, but at their value when the company took them over. With regard to the manufacturing business of the company, he was pleased to say that it had decidedly improved during the past few months. They would see that the manufacturing profit this year amounted to the sum of £3,070; last year the profits were only £1,848. That was a very satisfactory item. Equally satisfactory was the fact that although the interest from investments was considerably lowered, they were able to pay the same dividends as last year.

After some discussion the report and accounts were adopted.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31st, 1894, and payable on June 22nd. The transfer books of this company will be closed from June 15th to 21st, both days inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 27th, 1894, amounted to £931; week ending May 28th, 1893, £844; increase, £87; total receipts for half-year, 1894, £19,143; corresponding period, 1893, £18,579; increase, £564.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 25th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,287.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, May 23rd.	Closing Quotation, May 30th.	Business done during week ended May 30th, 1894. Highest.	Lowest.
184,500£	African Direct Teleg, Ltd., 4 % Deb.	100	...	...	...	101 —104	102 —105	104	103
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44	41 — 43	42¼	41
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	80½— 81¼	79 — 80	81	78¾
2,932,680£	Do. do. Defd.	Stock	...	...	...	7¼— 7⅜	7¼— 7⅜	7⅜	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6¼ % §	6¼ % §	12 — 12½	12 — 12½	12⅝	...
18,700£	Do. do. 5 % Bonds	100	...	...	...	100 —103	100 —103	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	108 —112	108 —112	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	1½— 2½	1½— 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —145	140 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	3½ % §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	12⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8¾— 9¼	9 — 9½	9¼	9⅛
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	9½— 10	9½— 10	9 13/16	9 11/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §	6½ % §	...	14¾— 15	14¾— 15	15 1/16	14¾
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15¾— 16	15¾— 16¼	16⅛	16
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	112 —115 xd	113 —116	113¾	113½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅜— 15⅝	15½— 15¾	15¾	15 9/16
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	104 —107	104 —107	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	104 —107	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	114 —117	...	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	104 —107	105½	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	104 —107	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	105 —108%	106 —109%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4⅞% §	4⅝% §	8¾— 9	8¾— 9	9	8⅞
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅜— 15⅝	15½— 15½	15 7/16	15¼
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗% §	8⅗% §	8⅗%	21 — 21½	21 — 21½	21⅛	21
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	43 — 45	43 — 45	44¼	43
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6 xd	4 — 6	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	106 —109	106 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞— 5⅛	4⅞— 5⅛	5	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14½— 15½	14½— 15½	14⅝	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½— 5¾	5½— 5¾	5¾	5 9/16
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	114 —116	114 —116	115¼	114⅝
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec, Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	1/32 — 2/32	1/32 — 2/32	...	...
100,000£	Pacific and European Tel, Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	112 —116	112 —116	...	...
58,000	United River Plate Tel-ph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½— 3	2½— 3	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	104 —106	100 —105	104	100
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7½— 8	7½— 7⅝xd	7⅝	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6½— 7	6⅝— 6⅞xd	6⅞	6⅝
33,129	Do. do. do. 5 % Def. ...	7½	3 %	...	...	2 — 2½	2 — 2½	2½	...
178,200£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	106 —109	106 —109	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1⅛— 1⅜xd	1⅛— 1⅜	1 5/16	1⅛
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10½— 10⅝xd	10½— 10⅝	10⅝	10½
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10 xd	9 — 10	9	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	109 —112	109 —112	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	110 —115	110 —115	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5½	4½— 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	12 — 13	12 — 13	12⅛	...
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13½— 14	13½— 14	13⅝	13 13/16
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) £75 paid	...	...	...	...	83 — 85	83 — 85	84½	...
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½%	5 %	5 %	6⅜— 6½	6⅜— 6½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	...	7½— 8	7½— 8	7 13/16	7¾
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	108 —111	108 — 111	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5½	4½— 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	6¾— 7¼	6¾— 7¼	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8 — 8½	8⅜	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6 — 6½	6½— 6¾	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, May 23rd.	Closing Quotation, May 30th.	Business done during week ended May 30th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	...	6 % §	6 % §	2⅞— 3	2¾— 3	2¾	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
125,000£	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	110⅜	110
630,000£	City and South London Railway	Stock	...	⅝%	⅝%	31 — 33	33 — 35	33½	32½
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 3½	3 — 3½	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼— ⅜	¼— ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1¼— 1¾	1¼— 1¾	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	½— ¼	¼— ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1⅜— 1⅝	1½— 1⅝	1½	1½
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1 — 1¼	1 — 1¼	1 1/16	⅞
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1½	½— 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	6½— 7½	6½— 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23½	23
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 7/16— 8 9/16	8⅝— 8¾	8¾	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12¾— 13¼	12¾— 13¼	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	1¾— 2¼	1¾— 2¼	2	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	40¼	40
150,000£	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	104 —107	104—107	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %§; 1891—7 %§; 1890—8 %§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅜—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5¼—5¼.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.

Liverpool Electric Supply, £5 (fully paid), 6½—6⅝.

Do. do. £3 10s. paid, 4¼—4⅜.

London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

At the ordinary general meeting of the Institution, on Thursday evening, May 24th, Mr. Alexander Siemens, President, in the chair, the discussion on Mr. Crompton's paper on "The Cost of Electrical Energy," was resumed.

Mr. E. de Segundo* said, in considering efficiency in a subject of this sort, he thought it was wiser to deal with the best possible rather than with the absolute efficiency. Now, Mr. Crompton assumed in his ideal that boilers could be made which would evaporate 12 lbs. of water at 150 lbs. pressure per square inch per lb. of fuel. That would correspond to an absolute efficiency, taking average coal of a calorific value of 14,100 Th.U., of 87·7 per cent.; but a boiler could not do impossibilities, and if they took into consideration the minimum amount of air which must be allowed to go into the furnace in order to complete the combustion of 1 lb. of average coal, they found that altogether 11·7 lbs. of products of combustion would find their way into the chimney. Assuming that the products of combustion went away at 400 degrees, and they passed into the furnace at 60 degrees, there would be carried away in thermal units 915. This heat was an absolute loss, and could not be utilised in any way. Allowing for this the maximum possible evaporation would be 12·8 lbs. of water at 150 lbs. per square inch. Mr. Crompton's estimate of 12 lbs. therefore meant a relative efficiency of 93·75 per cent. for the boilers. But they knew quite well that it was not always possible to regulate the supply so exactly that only the amount really necessary for the chemical combustion of the coal was produced, and assuming that they admitted 18 lbs. of air per lb. of coal consumed, which he did not think was too liberal an allowance, the maximum possible was reduced from 12·8 to 12·25 lbs. of water at 150 lbs. per square inch. Therefore Mr. Crompton's assumption of 12 lbs. really meant a relative efficiency of nearly 100 per cent. for that class of fuel. Of course it might be possible with a better class of fuel, but he thought it was worth while bearing in mind that it was an extremely high ideal to set before them. With regard to the engines, Mr. Crompton said condensing steam engines could be made which would give one I.H.P. per 13 lbs. of steam at from half to three-quarter load. Working that out in the same way, they found that 13 lbs. of steam at 150 lbs. per square inch contained 13,400 thermal units. One I.H.P. hour was equal to 2,540 thermal units, therefore the 13 lbs. assumption would amount to a 19 per cent. efficiency, which he submitted was a very high ideal indeed. They might reasonably assume a 70 per cent. all-round efficiency for the boiler, as a result which, at all events, could be calculated upon in practice. He allowed 10 per cent. for stand-by losses, and from calculations based on actual practice, he found that 10 per cent. was about the outside absolute efficiency one could count upon for high-pressure non-condensing steam dynamos. Assuming a higher class fuel, say, of 14,500 Th.U. calorific value, they could not hope to realise a better result than 4 to 4¼ lbs. of coal per kilowatt hour at the consumer's terminals. The next point he thought worthy of a little consideration was this: People did not care a bit how many watts were used for lamps; they did not buy watts, they only considered candle-power, and when they considered the efficiencies that had been obtained in the various units in their generating stations they could not hope for much improvement in boilers or dynamos or engines; but there was room for a great deal of improvement in the distributing system, and above all in the lamps.

Mr. Shoolbred, referring to what Mr. Crompton called works' losses, remarked that it had been said, with regard to boilers and engines, that works' losses appeared to be more remediable, and appeared to concentrate themselves in a great measure on the connections between the engines and boilers. The amount of loss arising through the changes of temperature which ended in breakages of joints and leakages of various kinds was very considerable, and was a great deal due, apparently, to the injurious system, which was still adopted in many cases, of allowing the boilers to cool instead of banking the fires. He could not follow Mr. Crompton when he said that Lancashire boilers seemed to produce rather worse results than the water-tube. In the water-tube there should be taken into consideration the results of the extinction of the fires and the cooling down, and the losses which arose therefrom. With regard to the relative economy of the various systems of converted alternating and converted continuous and direct continuous brought out in Table VI., Mr. Crompton drew attention, among other things, to the economy obtained from storage. He (the speaker) had had an opportunity offered him by the Bradford Corporation of seeing what was the actual visible effect in the economy provided by batteries. He had placed a number of diagrams on the wall which showed the working of the Bradford station for four years. Some of those diagrams showed that for a considerable period in the 24 hours the engines were shut down, and the work entirely in abeyance. Even in winter there was an appreciable period, some eight hours or so, of inaction, and they could not close their eyes to the fact that a considerable economy must arise from the relief granted to the engines, and the saving of time, wages, and so forth, and that any system that required the engines to run during that time must necessarily be more expensive

* Speakers marked with an asterisk have corrected their remarks.

in itself than the other. He had been enabled, likewise, to place on the wall diagrams showing the existing proportions of expenditure. Those diagrams would be interesting as showing the actual facts, which extended over a considerable period of time. Mr. Geipel, in his remarks, seemed to suggest, when speaking of the proportion of capital per unit sold, that Mr. Crompton's suggested 2s. was almost an impossible figure, especially for continuous current installations. The result of the working of the station at Bradford had been, that, during the whole of 1893, the proportion of capital had only been 2s. 6d. per unit sold, and there was good reason to suppose that 2s. might be reached before long. Mr. Hammond also said if 2s. ever was reached it would require a great many units to be sold. Last year the figure he had named was attained with slightly under half-a-million units. He was surprised to find that one who was so wedded to alternating currents should lay so much stress on what he called the bye-uses of current, by storage and motor working and other things. It showed how largely people were at last admitting that those things were matters which must form the mainstay of their installations by filling up the day curve. He could only repeat what had already been said, and thank Mr. Crompton, not only for what he had already done, but for the economies which would follow later as the result of the facts that he had placed before them, and had been the means of bringing out.

Mr. EDWIN N. HENWOOD* said Mr. Crompton had spoken of 2¼ lbs. of coal per I.H.P. hour being the ordinary work done in 1883, and, of course, he was perfectly well aware that during the last 10 years the consumption of coal in marine boilers had been reduced to 1·7 lbs. for triple expansion engines. Although people had still stuck to coal, no method had been devised during the past 60 years by which complete combustion could be obtained, with so poor a combustible as coal, there was the inevitable loss of about 25 per cent. by ash; moreover, the system of hand-firing by men using shovels was unscientific and wasteful and ought to be discarded. Mr. Crompton had expressed the opinion that mechanical firing was still more wasteful and inefficient, and in that he (the speaker) concurred. He, however, omitted to notice the loss due to the heating of the fire bars, for even with wood as fuel the ordinary cast-iron fire bars were quickly burnt out. A method had been tried of using tubes filled with water as fire bars, but the great loss was occasioned by the large furnace doors which admitted an excessive amount of cold air, with the result that the effectiveness was impaired and the boilers were injured. He quite concurred with the author's view, that it was best to use nothing but the coals of highest calorific values. He said, "we find very rarely that any form of furnace now in use is able to utilise any considerable percentage of these hydrogen units," and he then went on to refer to various types of boilers. No doubt they were aware that at the Glasgow station they had used a return tube boiler of the marine type. While he was no advocate of an inferior type of boiler, he must say that in his judgment an internally fired boiler was to be preferred to any other. If an improved water-tube boiler were devised so as to dispense with fire bars and a cold ash pit, it would be an improvement to be greatly desired. He was glad to find the author speak so well of the Babcock boiler, and stating that it could be forced without priming. It was, of course, of primary importance that it should be kept free from impurities of any kind. He (the speaker) wished to place it on record that in his judgment it was utter loss to attempt to use coal when burning oil, because it would not add anything to the effect, but would rather diminish the heat they obtained from the oil. In a properly constructed furnace for burning oil fuel the conditions were different from those which were in force when they burned coal. In the oil fuel furnace they needed to have the admission of air strictly under control and not to allow a large accession of injurious air to be drawn into the furnace, as was the detrimental and unavoidable custom when firing with coal; moreover, with an oil fuel furnace they entirely avoided the loss and nuisance occasioned by the constant feeding of the fire. He would like to describe a new type of water-tube boiler, known as Petersen's, which was far in excess, in point of value, of any other. In this there were seven tubes of ¾-inch diameter connected to one cup or header of wrought steel or iron, and there was only one connection with the steam drum, only one hole in the steam drum for seven tubes, which tubes might be anything from 2 feet to 5 feet long. He would ask them not to be too incredulous when he told them that with a reliable system of firing with oil he had obtained an evaporation of over three times that obtained by coal. It might be argued that it was known from laboratory tests that that was higher than was obtainable from the calorific value of the fuel itself *per se*. That might be so; but when they remembered that they had to use super-heated steam and the proper amount of air, and did not deluge the furnace with an excessive amount, it might be seen that they might get a far higher heat than many people imagined. It was great enough, at any rate, to melt fire bricks into a consistency similar to that of honey.

Mr. DYKES* said the figures Mr. Crompton had put before them were of the utmost value in enabling them to judge of the value of different systems and different pieces of apparatus; but it was important before they compared different systems or different types of engines on the basis of those figures that they should understand any conditions that modified the general result, and he therefore had pleasure in reading a letter from Mr. Tonge, engineer of the Preston Company, in which he gave a few details concerning that station. He did this because in Mr. Crompton's paper this was the only low tension station in which double-acting engines were used, and it would appear from that that the comparatively low efficiency of that station might be due to the particular type of engines or the particular system in use. Mr. Tonge wrote:

"Mr. Crompton in his paper on 'The Cost of Electrical Energy' has discredited the data as to the works' costs of the Preston station on the ground that they are abnormal. As this statement is misleading, and apt to create an impression that the works are unable to generate electrical energy at a cost which will compare with that of other works of similar output, I take this opportunity to place before you some figures, in the form of a table, showing the actual cost of generation and distribution per unit delivered to the customer for three periods, viz., January to June, 1893, July to December, 1893, and January to March, 1894. It will be seen that, with the exception of the cost of coal, which is somewhat erratic, all the items show a distinct downward tendency, and the total works' costs for January—March, 1894, are very satisfactory when the output is taken into consideration. The number of units delivered to customers in 1893 was 149,636. The cost of coal was largely affected by the coal strike, as will be seen by comparing the figures for the two halves of 1893. Coal is now costing us from 20 per cent. to 25 per cent. more per ton than in the early part of 1893, so that the figure 1·062 in the table for the first quarter of 1894 is really a considerable improvement on the cost for the corresponding part of 1893. I also think that Mr. Crompton's figures for the heat units per watt-hour at our works should be altered. Apparently no allowance has been made for the extra cost due to the coal strike, and, therefore, too high a value has been put on the coal used. In regard to the efficiency of distribution, which Mr. Crompton puts at 80 per cent., I am altogether at a loss to understand how he arrives at this value. In his letter of enquiry he asked me for the efficiency of distribution, taking units as = units supplied to customers + units used by company + units generated. The figures I supplied him with showed that for 1893 this works out at 93 per cent. Even supposing the efficiency of distribution be taken as = units supplied to customers + units generated, the result works out at 86 per cent. Both figures are much better than the 80 per cent. which Mr. Crompton gives. In conclusion, I would observe that, as we have no batteries, our engines, &c., are run under conditions more nearly resembling those in an alternating current works than in a low-tension station with batteries."

COST OF GENERATION AND DISTRIBUTION PER UNIT DELIVERED TO CUSTOMERS.

	Jan.—June, 1893.	July—Dec., 1893.	Jan.—Mar., 1894.
Coal, &c.	1·25	1·94	1·062
Oil, waste, water, and petty stores	·51	·28	·181
Wages and salaries ...	1·35	1·30	·813
Generation and distribution			·060
Repairs and maintenance—			
Plant at station ...			·178
Main services and meters	31	·30	·116
Motors and arc lamps			·30
	3·42	3·82	2·710

The reason why, Mr. Dykes continued, the station costs appeared so high was that the present company had to take over a number of contracts with the Corporation and others for running arc lamps, incandescent lamps and motors which were owned and kept in repair by the company, and who also provided carbons and brushes. These costs did not really fall under the heading of generation and distribution expenses, and they had been kept separate in the table. It would be evident on inspection of the figures that the cost of coal was very largely affected indeed by the coal strike of last year, and it was peculiar that in the North, where coal was very low in value, only costing before the strike 6s. 3d. or 6s. 6d. instead of 20s. or so, as was the case down here, they were affected by the strike considerably more than people in the south, the cost of coal being nearly doubled. Mr. Tonge further wrote that the efficiency of the engines and dynamos amounted to 82 or 83 per cent., which, considering that the sets were only 100 H.P., compared very favourably with those of other types. The actual water consumption had been found in practice to be 27 lbs. per E.H.P., and the coal consumption per unit sold was 29 lbs., a figure which might be of some importance as showing what was actually obtained with that kind of coal, the coal being small slack burnt in Lancashire boilers, non-condensing. The best consumption of coal for a period of over three weeks in winter was 17½ lbs. Throughout the engines had given the greatest satisfaction both as regards up-keep and steady running. There was no doubt these figures could be largely improved by the use of a moderate amount of storage, and it showed that even with an efficient generating plant running day and night, with three shifts, at comparatively light load, the profit was brought down considerably. It was only right, he thought, that figures which greatly modified those published results should be brought before them, so that they could see exactly why it was certain stations compared badly, and what were the conditions which caused this comparatively high consumption.

Prof. UNWIN* said that Mr. Crompton had made some rather strong statements about the relative value of Welsh coal and coal of any other description. He admitted that in calorimeter tests the north country coal was nearly as good as Welsh coal. But Mr. Crompton said there was some difficulty in burning the hydro-carbons of the northern coal, and that this made it practically much less valuable. A long series of tests was carried out between 1860 and 1870, partly for the Admiralty and partly for other people, the general result of which was that there was practically no difference between northern coal and Welsh coal. It was smokelessness not calorific power which gave Welsh coal its great market value. Prof. Kennedy carried out a series of tests of marine engines on a large scale, and in the whole of that series there were but three tests in which an evaporation of over 10 lbs. per lb. of coal was obtained, and of those three tests two were made with northern coal and one with Welsh, and there was no appreciable difference between them. Mr. Crompton also made some rather strong assertions about the economical efficiency of Lancashire

boilers; indeed, he went so far as to say that a Lancashire boiler was only half a boiler, and that you had to put an economiser on to it before you made it a whole boiler. Well, there were a good many tests one could point to traversing that statement, but he would only quote one. Two or three years ago he had to carry out some tests at a London pumping station of Cornish boilers, which, after all, were only Lancashire boilers with one flue. The boilers were not new, but were taken in the ordinary course of their use. The trials lasted 24 hours, and the measurements were carried out with exceptional accuracy. These boiler tests gave an evaporation of 11·87 lbs; but they were only half boilers, without economisers. He (the speaker) believed the Babcock boiler was an excellent one, as good as any made; but in the paper it was especially praised because it would stand forcing. All he would say about that was that Mr. Crompton did not give them a single fact to enable them to judge whether it would or not. He said it was nominally rated at so much, and that it had been worked at 50 per cent. above that. He had not told them what the evaporation was per square foot of its heating surface; probably it was moderate. A comparison had been drawn between short-stroke high-speed engines and what Mr. Crompton called long-stroke slow-speed engines. It was pointed out that Mr. Willans showed how great the importance of high speed was in controlling cylinder condensation. He did not doubt that Mr. Crompton knew perfectly well, but in the paper he had so written as to convey the impression that this high speed was the one special mode of combatting cylinder condensation; it was not sufficiently put forward that there were three or four other methods. They might reduce it 20 per cent. by steam jacketing, 20 per cent. by super-heating, 20 per cent. by high speed, and 20 per cent. by multiple stage expansion; but, unfortunately, they could not get 80 per cent. by adopting all those methods together. It came to a question of which was the right one to adopt. As Mr. Robinson fairly and frankly said at the last meeting, up to the present it was the long-stroke slow-speed engines which had given the highest economical results, and that required to be borne in mind along with the statements about the necessity of high speed and short stroke. It all came to this, Mr. Crompton had given a formula for station arrangement something like this: Welsh coal, Babcock boilers, high-speed, short-stroke, direct coupling. Well, that was an excellent formula; but he did not think it was the only good formula, and he must say that he had an impression that this kind of formula was, on the whole, extremely mischievous. Every central station designed had to be considered according to the circumstances of its locality and various other things, and he did not think they could lay down any such simple formula as that for the correct method of arrangement. There was one other point, which was not exactly criticism, upon which he might give a word or two of information which might be new to some of them. Mr. Crompton had very rightly looked to super-heating as a method which would in the future have to be adopted in securing further economy in the working of steam engines. He objected rather to the view that super-heating was to be used as a remedy for steam-pipe condensation, which he thought must be combatted in other ways. It had the more important function of reducing cylinder condensation. In speaking of super-heating, Mr. Crompton told them that 20 or 25 years ago, when it was first used, it was easy to adopt super-heating, but now it was difficult because steam was now of very much higher pressure; he said with steam at 375°, "any further super-heating is very much in the nature of passing this steam through pipes at a temperature which nearly amounts to red heat, so that it is little wonder that not many engineers have cared about tackling such a difficult and risky problem." A year or two ago he (the speaker) had an opportunity of testing in Alsace an engine using super-heated steam. He was not exaggerating when he said that there were now many hundred engines working with steam up to 100 or 120 lbs. per square inch pressure which were worked with super-heated steam. He tested an engine which was not at all on a small scale—one of 500 H.P.—constructed only about four years before, with separate admission and exhaust valves, as good a compound engine as he supposed could easily be found, having steam-jackets and every appliance for economising steam. He ran the engine for three days, two days with super-heat, and one without, obtaining an economy of 20 per cent. in coal and 20 per cent. in steam when the super-heated steam was used. The steam chest of the engine was at a temperature of 520° Fah., and the engine had been working with that super-heated steam for two years without the cylinder covers being taken off. The fact was, there were difficulties about using super-heated steam in modern days, but some of the difficulties put forward were not difficulties at all, but some which really existed were not sufficiently appreciated. The one difficulty always put forth was that with steam of this high temperature they would destroy their engine cylinder. That was an absolute fallacy. In the engine just mentioned, with the steam entering the steam chest at 520°, there was no super-heat inside the cylinder, the whole being expended in preventing initial condensation. The dryness fraction at the cut off was 0·65 with saturated and 0·85 with super-heated steam. He admitted that in Alsace they had a rather favourable case for using super-heaters. Elephant boilers were largely used, and they dug a pit beneath the boiler and put the super-heater down below; they had exceedingly little difficulty under those conditions. As far as he could learn, and he went through many mills, the stokers paid absolutely no attention to the super-heaters, and did not even know whether they were on or off. Now, in the old days, when super-heating was first introduced, he thought two very serious mistakes were made. At that time the super-heater was invariably placed in the coldest part of the boiler tubes, in the up-take, or in some part where the gases left the boiler, consequently the super-heater was large, cumbrous, and unsafe. If they had steam at a high temperature, and were going to super-heat that, it was of no use putting the super-heater in the coldest part of the flues, where they had not temperature enough to do the work; to use the super-heater effectively they must put it somewhere where the gases were of high temperature, and in Alsace they put it immediately behind the bridge. If they put it in a cold part of the flues, they must have an enormously large and therefore dangerous super-heater, but if they put it behind the bridge they might use a small and safe super-heater. It must be assumed that the super-heater would stand all the chances of daily work. If it was to do that it must sometimes, no doubt, approach the temperature of red heat, but he did not think it ever reached it. He thought, but was not sure, that that would exclude them from using a ductile material like mild steel in constructing the super-heater; at any rate, the super-heater must be so constructed that it had practically a solid metallic construction without any jointing at all. Unless they could get that he thought the super-heater would gradually be destroyed. There were problems, no doubt, still to be worked out, but he thought the fact that super-heating had been so largely used in Alsace, and that wherever used it had shown economies ranging from 10 to 20 per cent., in good, new, compound engines, was very encouraging.

(To be continued.)

Physical Society, May 11th, 1894.

Walter Baily, M.A., Vice-President, in the chair.

A mathematical communication On Electro-magnetic Induction in Plane, Cylindrical, and Spherical Current-Sheets and its Representation by Moving Trails of Images. By G. H. Bryan, M.A. Part I., General Equations, was read by Dr. C. V. Burton, who also explained some of the parts in greater detail.

After mentioning that the magnetic field due to induced currents in thin conducting sheets placed near moving magnetic poles could be represented by moving trails of images of those poles, the author goes on to say that in the paper the surface conditions which hold at the surfaces of the sheets are deduced directly from the fundamental laws of electro-magnetic induction.

I. "The total current across any enclosed portion of a surface which always contains the same particles, is equal to $\frac{1}{4\pi}$th of the time-integral of the magnetic force round the curve bounding the surface;" and (II.) "The rate of decrease of the surface-integral of magnetic induction across any enclosed surface, which always contains the same particles, is equal to the line-integral of electromotive force round the curve bounding the surface." By working with the scalar magnetic potential instead of vector potential the investigation is simplified. In addition to the above laws the author makes the usual assumptions that displacement currents in the dielectric is so small as to be negligible, and that the induced currents are distributed uniformly through the thickness of the sheet. On these suppositions the surface conditions satisfied by the potentials at the two sides of plane, cylindrical, or spherical sheets are determined, and, with an additional limitation as to the thickness of the sheet fulfilling certain conditions, extended to current sheets of other forms. In the latter part of the paper a synthetic determination of the images in a plane sheet is given and expressed in the form of a definite integral.

In reading the paper to the meeting Dr. Burton pointed out several misprints in the proof.

Prof. Minchin showed that equation (1) of the paper ($\Omega_2 - \Omega_1 = 4\pi\phi +$ constant, where Ω_2 and Ω_1 are the magnetic potentials at the two sides of the sheet and ϕ the current function), could be deduced by purely mathematical reasoning, instead of being based on the laws of electro-magnetic induction. Moreover it was true for any function whatever, and did not depend on ϕ being the current function. Equation (2) $\left(\frac{d\Omega_2}{dz} = \frac{d\Omega_1}{dz}\right)$ followed immediately from the fact that the magnetic force was continuous. The latter part of the paper might be simplified by integrating the linear partial differential equation (15) $\left(\frac{d^2\Omega'}{dz\,dt} - \kappa\frac{d^2\Omega_1}{dz^2} = -\frac{d^2\Omega_0}{dz\,dt}\right)$ in the ordinary way, for the form was one for which the auxiliary equations are well known.

Dr. Burton, in reply, said he thought Mr. Bryan's reason for developing the equations from the laws of electro-magnetic induction, was to give his work a physical rather than a mathematical basis.

A paper on Dielectrics was read by Mr. Rollo Appleyard.

In testing the insulation resistance of celluloid by having a sheet pressed between two metal plates, the author noticed that the resistance, which was very high, *decreased*, as the time the testing battery was left on increased. The "electrification" (using the word to indicate the rate of diminution of galvanometer deflection) was therefore *negative*. The resistance also diminished greatly with increase of battery power, and a considerable amount of hysterises was observed. The resistances at any given voltage, after a minute's electrification, depending on the previous history of the specimen. On making contact with the surfaces of the celluloid by mercury instead of by solid metal, the abnormal results disappeared, little or no resistance-hysteresis, or "electrification," being present, and only a small diminution of resistance with increase of voltage. For a 6 mil sheet the resistance between opposite faces, 5½ inches diameter, was of the order 30 megohms, and one specimen broke down at 1,200 volts. The celluloid condensers used in the experiments were found to discharge slowly at first, and after a certain time the deflections of the galvanometer became reversed and attained a steady negative value. This the author attributes to an E.M.F. of about 0·0006 volt between the mercury and celluloid. Similar experiments on gutta-percha tissue showed no such E.M.F., and the "electrification" was normal. The resistance usually attained a maximum for voltages between 600 and 800. Although the tissue had a thickness of only 2 mils (0·002") it

stood a pressure of 1,200 volts, and offered a resistance between circular faces, 5½ inches in diameter, of about 3,000 megohms.

The opaque white spots seen in celluloid under the microscope led the author to test the behaviour of mixtures of conducting and insulating materials. A strip of gutta-percha was warmed and coarse brass filings scattered over it as thickly as possible. In spite of this the resistance was practically infinite even when tested with 750 volts. A number of rods were made from mixtures of brass and gutta-percha in various proportions, and on testing these it was found that if the weight of filings exceeded about twice that of the gutta-percha, the resistance of a rod, 20 inches long, ¾-inch diameter, was small (sometimes a fraction of an ohm), whereas a slightly smaller proportion yielded rods having resistances measured in thousands of megohms. Such rods were found to be affected by oscillating discharges in a manner similar to Prof. Minchin's "impulsion" cells and M. Branly's tubes of filings. Experiments were also made on the behavour of such rods when subjected to high alternating pressures. This causes small local arcs to form along the rods, but did not permanently destroy their high resistance.

In connection with Mr. Appleyard's paper, a NOTE ON THE BEHAVIOUR OF CERTAIN BODIES IN PRESENCE OF ELECTRO-MAGNETIC OSCILLATIONS, by Prof. G. M. MINCHIN, M.A., was read by Mr. ELDER.

Referring to the employment of impulsion cells, metallic films, &c., for detecting the nodes of electro-magnetic vibrations, he says that so far the physical state of such bodies are too variable to be of service. Metallic surfaces formed by embedding fine metallic powders in films of gelatine, shellac, or sealing wax, are, as described in a previous communication to the Society, found to act as insulators, but became conducting when subjected to strong electro-magnetic disturbances. After a current has once passed through such a film its resistance is changed by very feeble impulses, whereas previously it failed to respond to strong ones. On breaking contact by removing the electrode from the surface, the film loses its conductivity, the time necessary to do this depending on the hardness of the matrix. The resistance of a film containing tin powder, measured between the rounded tips of two platinum wires 1 cm. apart, varied under the electro-magnetic impulses, from ∞ to 130 ohms. In conclusion the author points out that with films and tubes the whole phenomenon relates to change of resistance, whereas impulsion cells may have currents from external sources passing through them whilst in either the sensitive or insensitive states.

BEDFORD ELECTRIC LIGHTING.

IN our last issue we stated that the Town Council had resolved to adopt the scheme of Mr. F. H. Medhurst. The following is an abstract of Mr. Medhurst's report on the subject:—

It is unavoidably necessary, in bringing this matter before you, to use a few electrical terms. First, a "volt" is the unit of electrical pressure. Second, an "ampère" is the unit of quantity of current. Third, a "watt" is the unit of power; it is pressure multiplied by current. A "kilowatt" is 1,000 watts, and a "Board of Trade unit" (usually simply called a unit) is 1,000 watt-hours; 10 ampères at 100 volts, or 100 ampères at 10 volts, or 50 ampères at 20 volts, equals one Board of Trade unit, which is equal to 1·34 H.P. working for one hour.

The most important systems in vogue in England are:—(1) High tension alternating current with transformer sub-stations, and (2) low tension direct current with accumulators. The first system is the one best suited for town lighting in cases where the area of supply is likely to ultimately reach beyond the limits of a circle with a 500-yard radius. An objection, too, to the continuous current system is that it practically necessitates a site for the generating station in the centre of the district to be supplied—otherwise the cost of copper for conductors becomes prohibitive, for the size of the mains depends on the quantity of current to be conveyed, and not on the pressure or voltage. The site that I strongly recommend for the generating station is in Prebend Street, and is already the property of the corporation, so that no capital outlay need be incurred in purchasing land for the electricity works. Other advantages of this site are that it is on the bank of the River Ouse, so that water will cost nothing for condensing purposes, and for feeding the boilers. Then, again, the works will not be sufficiently near dwelling-houses to render the corporation liable for smoke nuisance or vibration due to running machinery. This latter trouble has been a source of considerable expense and litigation to the London electric supply companies. There is ample room for extensions, which will have to take place in order to provide for the additional machinery that will, in all probability, be required in the next two or three years. The general arrangement of the machinery is clearly shown in the accompanying plans. I propose, in the first instance, to provide three steam alternators, each capable of supplying sufficient current for 1,000 lamps of 10 C.P., each alight at one time. One plant will be spare, so that I am now making provision for 2,000 lamps of 10 C.P. each alight at one time. Experience in other towns has shown that never more than 50 per cent. of the lamps wired are in use simultaneously, so that 4,000 lamps of 10 C.P. may with safety be in electrical connection with the mains. The engine room is purposely made large enough to take a fourth plant (with a capacity of 2,000 lights of 10 C.P.) without any further outlay in building, other than that necessitated by the provision of additional foundations. It will be noticed that I have provided a small gas engine and alternator, and this set is intended to run during the daytime or time of light load. It is well known that the principal reasons for the great difference between the actual coal consumption at electricity works and the theoretical consumption, are (1) low efficiency of boilers and steam engines at light load, and (2) condensation of steam in steam pipes at light load. The effect of the gas engine plant would be to make it possible to bank up the boilers during, say, 16 hours (two shifts) out of the 24 hours, to dispense with a stoker in each of these shifts, and merely to retain one man to run the gas engine set. In this way there will be a saving of £130 per annum in labour and about £40 per annum in coal. There will also be the mechanical advantage (and it has been shown that this is an economical advantage as well) that there will be no steam in the pipes during two-thirds of each day of 24 hours. It may, of course, be argued that if there be no demand for electric light in cellars and dark passages, it will not be necessary to run the machinery continuously. But I am strongly of the opinion that the policy of running during the night only is a bad policy, because it at once places electric light at a disadvantage as compared with gas, which is available at all times. In order to reduce the coal bill to the lowest possible limit, I have included an economiser in my estimate. I propose to have two boilers in the first instance, one being spare, and each boiler being capable of evaporating 2,500 lbs. of water per hour.

The following is a summary of cost of initial installation:—Three 30-unit alternators, £750; two exciter dynamos, £120; three 45 B.H.P. compound condensing engines, £860; two 6 B.H.P. condensing engines for exciters, £155; gas engine and alternator, £280; engineering charges and contingencies, £870; switchboard, £300; pipes, cables, and joint-boxes, £2,700; transformers, £265; buildings, £2,300; two boilers, £634; economiser, £140; surface condenser, £250; two feed pumps and tank, £56; steam pipes, £400; travelling crane, £120; total, £10,200.

Distribution.—At present it is intended to lay a 6-inch pipe from the generating station to the corner of Prebend Street and Commercial Road; 4-inch pipes would be laid along Prebend Street, Midland Road, Harpur Street and Dame Alice Street to a transforming sub-station, or a buried transformer at the corner of High Street, Dame Alice Street, and St. Peter's Street. There will be another sub-station at the corner of St. Paul's Square and High Street, and a 4-in pipe will, of course, be laid along Commercial Road, Horne Lane and St. Paul's Square. From these two transforming sub-stations (one at either end of the High Street) mains will at present be laid in the High Street only, though I anticipate that it will almost immediately be necessary to lay distribution mains in St. Paul's Square, Silver Street and Mill Street. It must be borne in mind that the high tension mains can be tapped anywhere on their route by merely connecting a transformer, and laying low tension service wires from the secondary terminals.

Revenue.—It is obvious that before arriving at a reliable estimate of revenue, the probable consumption of electricity must be calculated. In order to aid me in forming an accurate opinion on this score, I instructed one of my assistants to thoroughly canvass the High Street. The result of this canvass far exceeded my most sanguine expectations, the equivalent of no less than 3,000 lamps of 10 C.P. being required for the shops alone. As this canvass did not include private houses, and as the actual demand is invariably in excess of the apparently probable demand, as indicated by a house to house canvass, I feel certain that I am well within the mark when I estimate that 4,000 lamps of 10 C.P. will be in electrical connection with the mains when the supply of electricity is commenced. If, as I should advise, 6d. per Board of Trade unit be the price charged to private consumers, then the revenue per lamp per annum will work out at 10s.; 4,000 lamps at 10s. per annum is equal to £2,000.

Working Expenses.—Engineer, £200; junior electrician, £52; engine drivers, £182; coal, 139 tons at 15s., £104; gas, 289,000 cubic feet, £47; cleaner, £52; stoker, £78; lad (odd jobs), £26; jointer, £104; oil, waste, and petty stores, £80; repairs, £100; insurance, £20; rent, £20; total £1,065.

On the above basis the cost per unit works out at 3·2d. It is, however, necessary to add interest on capital and redemption to the working expenses, in order to arrive at the actual financial result. Assuming that the corporation can borrow at 3 per cent., and that the loan has to be repaid in 25 years, we have the following result:—

Revenue		£2,000
Working expenses	£1,065	
Interest and redemption, together 5½ per cent. on £10,200	561	
		1,626
		£374

It will be wise to set aside an annual sum equivalent to 3 per cent. on the total capital expenditure in order to provide for depreciation on plant, buildings, mains, &c. Even after this has been done, the actual net profit on the undertaking will be £68 per annum, and, as £100 has already been allowed for repairs in calculating the working expenses, I am convinced that 3 per cent. on the total expenditure is a most liberal allowance. When it is borne in mind that at 6d. per unit electricity will not be more expensive than gas at 3s. 3d. per 1,000 cubic feet, and that even with only 4,000 lights of 10 C.P. connected to the mains the corporation can make a profit or otherwise reduce the rate per unit, and further that as the demand for electricity increases and additional machinery has to be provided to meet it, the working expenses will increase less, proportionately, than the revenue, it must be admitted that the Corporation possess a very valuable monopoly in their provisional order. I estimate that the maximum demand in Bedford will not, for many years to come, exceed the equivalent of 18,000 lamps of 10 C.P. in electrical connection with the mains.

I show in the accompanying plan how I propose to extend the buildings and what plant I propose to provide in order to meet this increased demand. It is evidently impracticable to give an accurate

estimate of the ultimate capital expenditure on the undertaking, because it is impossible to say definitely at the present time what mains will have to be provided until the occasion arises and the intending consumers are known. I estimate, however, that the total capital expenditure will not exceed £37,000, while the gross revenue will be £9,000 per annum. The total working expenditure will be £3,800, interest and redemption £2,035, and depreciation £1,010, leaving a net profit of £2,155.

Street Lighting.—All my estimates have been based on an incandescent installation, but if the High Street, for example, were lit by means of arc lamps, this could be done by 10 lamps of about 1,200 actual candle-power each, placed at intervals of 90 yards on either side of the road—five lamps on each side. It would not be necessary to provide extra boiler or engine power at the generating station for these public lights, though it would be necessary to provide the requisite cables and a motor commutator to convert the alternating into an undulating or practically continuous current. The total cost, then, of providing the High Street with arc lamps, would be £600, whilst the current, together with interest and redemption, will cost the Corporation £16 per lamp per annum, assuming that 10 hours per day be the lighting hours.

NEW PATENTS -1894.

9,534. "An improved device for use with current meters in observing the charging and discharging of electric accumulators." A. KOLBE. Dated May 15th.

9,540. "Improvements in or relating to incandescent electric lamps." A. H. POLLEN and A. DUNOLLY. Dated May 15th.

9,565. "Improvements in the metal screw, bolt, or other atttachments for fixing insulators to carry electric wires." A. GRAY. Dated May 16th.

9,586. "Improvements in material for lessening and impeding the transmission of vibration in railway carriages, trucks, horse boxes, locomotives, and stationary engines." G. POWELL. Dated May 16th.

9,605. "Improvements in electric machines." W. M. MORDEY. Dated May 16th.

9,627. "Improvements in the mechanism of arc lamps." C. N. DEXTER. Dated May 17th.

9,647. "Improvements in and connected with telephones." J. NICOLSON. Dated May 17th.

9,664. "Improvements in pyrometers." E. A. UEHLING and A. STEINBART. Dated May 17th. (*Complete.*)

9,670. "Improvements in steam turbines." J. S. RAWORTH. Dated May 17th.

9,673. "Improvement in means for the distribution of alternating electric currents." D. COOK. Dated May 17th.

9,690. "An improved electrical device for facilitating the lighting of gas." J. JAHNSSON. Dated May 17th. (*Complete.*)

9,709. "Fuel economiser." E. MASON. Dated May 18th.

9,743. "Improvements in electric conductors principally designed for lighting and heating purposes." E. BAILEY. Dated May 18th.

9,761. "Improvements in electrolytic apparatus." T. CRANEY. Dated May 18th. (*Complete.*)

9,762. "Improvements in arc lamps." J. W. ROGERS. Dated May 19th.

9,763. "A horary meter for electric light, air, gas, water (compressed or not) and motive force." P. CADOT and A. CHARRON. Dated May 19th. (*Complete.*)

9,813. "Improvements in or applicable to meters or apparatus for supplying electricity, gas, or other substances in exchange for coin." P. R. ALLEN. Dated May 19th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

238. "Improvements in and relating to the Deprez-D'Arsonval galvanometer." H. W. SULLIVAN. Dated January 5th. In place of a single magnet two or more magnets are used, with their like poles joined by pole pieces, and the coil, which may be single or compound, swings in the focus of the strong magnetic field thus produced. The magnets are tapered at their ends to fit against, or into, their respective pole pieces, and arrangements are provided for varying at will the deflecting moment of the instrument, with a given strength of current. 6 claims.

660. "An improved method of manufacture of elements or plates for secondary batteries." H. F. K. PICARD and H. THAME. Dated January 11th. Has for its object the production of an element or plate, of which the body is of finely crystalline salts of lead, or salts of lead and metallic lead intimately commingled, and is homogeneously and metallically connected to an upper rim of lead, by which, or on which, a pole piece may be formed with perfect metallic continuity from the body of the plate or element. 4 claims.

1,697. "An improved electric clock." G. BINSWANGER and H. J. COATES. Dated January 25th. Relates to an improved electric clock, having for its objects the attainment of a regular and uniform impulse to the pendulum of practically unvarying force, although the strength of the electric current driving it may vary considerably, thus ensuring correct timekeeping, independently of said current. 3 claims.

2,403. "Improvements in the means of distributing electrical energy, and in dynamos and other apparatus therefor." J. A. KINGDON. Dated February 3rd. Consists of an improved means of working what is known as the "three-wire system" of electrical distribution; but it may also be applied to more complicated multiple series systems worked with continuous currents. Instead of using two dynamos connected in series, the inventor employs but one dynamo of a new or improved type, and furnished, in addition to the ordinary positive and negative poles, with a third pole, which is at a potential intermediate between that of the other two. 4 claims.

3,101. "Improvements in the insulation of armatures of dynamo electric machines." C. W. JEFFERSON. Dated February 11th. Consists in making the insulators of artificially built up mica scales. 13 claims.

3,831. "Improvements in telephone exchange systems." J. E. KINGSBURY. (A communication by the Western Electric Company of Chicago.) Dated February 21st. Relates to telephone exchange systems in which the operating coil of an annunciator is permanently connected from one limb of each line to the other limb of the line in a closed bridge. According to the invention mechanism is provided for opening the normally closed bridge in which the operating coil of the individual annunciator is included, and this mechanism is adapted to be actuated by the current in a local circuit, which is closed when connection is made to the line. 3 claims.

5,064. "Improvements in electric clocks." J. CAUDERAY. Dated March 8th. The inventor substitutes for the weight or spring of ordinary clocks a battery and an electro-magnet which converts the electric energy into motion. 3 claims.

5,101. "Improved system of electrically interlocking signals and points, and in apparatus therefor." G. E. FLETCHER. Dated March 9th. Claims:—1. Electrically interlocking railway signals, and signals and points by means of two local and one main line circuit operating conjointly, substantially as set forth. 2. Apparatus for interlocking railway signals, and signals and points consisting essentially of two or more ring or closed circuit electro-magnets, and latches combined, with local and main line circuits and operating devices, substantially as set forth.

5,638. "Multiple change-over mechanism for electric arc lamps." W. J. DAVY. Dated March 16th. The object of the invention is to provide an improved change-over mechanism for electric arc lamps, whereby a series of pairs of carbons are successively and automatically brought into use and consumption, the said mechanism being applicable to arc lamps of the kind known as non-focusing lamps as well as to those known as focusing lamps. 5 claims.

5,778. "An improved process of manufacturing bleaching solutions by electrolysis." A. J. BOULT. (A communication from Dr. O. Knoefler and Fr. Gebauer, of Charlottenburg.) Dated March 17th. Claim:—A process of manufacturing a bleaching solution, consisting in subjecting a solution of mineral salt without the employment of diaphragms to electrolysis with a density of current of from 300 to 800 ampères per square metre of electrode surface, the extent to which the lye is made richer in active chlorine being determined by correspondingly regulating the rise of temperature, while conversely, by maintaining a uniform rise of temperature, an equally uniform percentage of active chlorine may be secured in the lye produced, substantially as specified.

5,782. "Improvements in telegraph poles." T. G. MARSH. Dated March 17th. The inventor makes metal telegraph poles in sections for easy transport, which fit the one into the other. The bottom section is preferably provided with a foot, which is buried in the ground, and its upper end has a conical socket. The intermediate sections are conical at their lower ends, and have conical sockets at their upper ends, whilst the top section is conical at its lower end. The conical ends of each section fit into the sockets of the sections below them, and are preferably fixed by means of a projection on them which passes down a groove in the socket, and by turning them is forced along an incline or groove at the bottom of the socket. The upper section or the upper part of it may be covered with insulating glaze or material, as is also the cross bar carrying the usual insulators, so that if the wire becomes detached from the insulator and drops on the cross bar or comes against the pole, it is still insulated to a certain extent. 2 claims.

7,703. "Improvements in electric signalling apparatus and systems for railways." J. Y. JOHNSON. (A communication from abroad by J. W. Lattig and W. F. D. Pascoe, of America.) Dated April 15th. Relates to an automatic block system of danger or home and caution or distant signals, similar to that described in patent No. 7,702 of April 15th, 1893, and, like the latter, contemplates the employment of an electric motor for actuating the signal operating mechanism to move the signal to safety. The particular form of electric motor is a solenoid or sucking magnet, to the core or cores of which the signal actuating rod is connected. 3 claims.

9,805. "Improvements in contacts for making and breaking electrical circuits." SIEMENS BROTHERS & CO., LTD., and F. JACOB. Dated May 16th. Claim:—An electric contact consisting of two magnetic parts, the one movable as in a door or window, the other stationary as in a door jamb or window frame, so arranged that the one is moved so as to make or break contact for an electric circuit when the other is near it, substantially as described.

10,623. "Improvements in printing telegraphs." D. MURRAY. Dated May 30th. Is designed, by means of a transmitting device provided with an ordinary keyboard, such as the Remington, to operate at a distant station any ordinary typewriter or other keyboard machine, such as a type-setting machine, the Rogers typograph, or Mergenthaler's linotype. 14 claims.